UNEP

industry and environment

ISSN 0378-9993
Industry and Environment
Volume 27 No. 1
January - March 2004

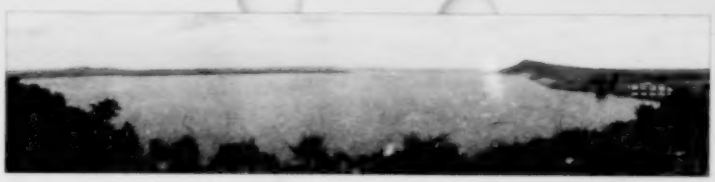
A publication of the United Nations Environment Programme
Division of Technology, Industry and Economics

Une publication du Programme des Nations Unies pour l'environnement
Division Technologie, Industrie et Economie

Una publicación del Programa de las Naciones Unidas para el Medio Ambiente
División de Tecnología, Industria y Economía

Water and development: industry's contribution

- Policy outlook
- Risk management
- Innovation
- Sanitation
- Dams and nature



Industry and Environment is a quarterly review published by the United Nations Environment Programme Division of Technology, Industry and Economics (UNEP DTIE), Tour Mirabeau, 39-43 quai André-Citroën, 75739 Paris Cedex 15, France. Tel: +33 1 44 37 14 50; Fax: +33 1 44 37 14 74; E-mail: unep.tie@unep.fr; http://www.uneptie.org

Director
Monique Barbut

Editorial Board
Michael Chadwick
Claude Fussler
Nay Htun
Ashok Khosla
William H. Mansfield III
Haroldo Mattos de Lemos
Walter Reitzsch
Léon de Rosen
Sergio C. Trindade

Editorial Staff
Françoise Ruffe
Robert Bisset
Rebecca Brite
John Smith
Thalia Stanley

Editorial Policy

The contents of this review do not necessarily reflect the views or policies of UNEP, nor are they an official record. The designations employed and the presentation do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any country, territory or city or its authority, or concerning the delimitation of its frontiers or boundaries.

The non-copyrighted contents of this review may be reprinted without charge provided that **Industry and Environment** and the author or photographer concerned are credited as the source and the editors are notified in writing and sent a voucher copy.

Industry and Environment welcomes for possible publication feedback from readers, news on their sectors of activity, or articles. The editors cannot guarantee publication or return of unsolicited manuscripts, photographs and artwork. Manuscripts which do not conform to the conventions and standards of the review may be returned for revision.

Subscriptions

Industry and Environment is subject to an annual subscription fee of US$ 60.00. See back cover for order form. Upon application to the Director, submitted on letterhead, the annual subscription charge may be waived for government, educational and non-profit organizations in developing countries which are unable to remit payment.

Industry and Environment is available on-line at www.uneptie.org/media/review/ie_home.htm.

Industry and Environment is printed on 100% chlorine free paper.

Contents

◆ Freshwater and industry

3 Editorial: the water business: commitments and opportunities

4 Freshwater and industry: facts and figures

10 Objectifs de développement du Millénaire, nouvelle gestion de l'eau, contribution du monde des entreprises et des affaires – *by Pierre-Frédéric Ténière-Buchot*

13 Water and industry: challenges and opportunities – *by Andrew Speers*

17 Water policies in the 21st century – *by Asit K. Biswas*

20 Act locally! How to involve small-scale enterprises in providing water supply to rural areas – *by François Brikké*

22 Meeting targets for water supply and sanitation: the African challenge – *by Shehu Yahaya*

25 The potential for private sector partnerships to protect marine/coastal areas through national action programmes – *by Erin Marie Hyland*

28 Dams and nature: negotiating enough water for life – *by Achim Steiner*

31 The changing water cycle and the insurance industry – *by Andrew Dlugolecki*

35 Bioremediation, phytotechnology and artificial groundwater recharge: potential applications and technology transfer issues for developing countries – *by Goen Ho*

39 Water scarcity, desalination and pollution – *by Walid A. Abderrahman and Tahir Husain*

41 Towards a new form of urban sanitation and water infrastructure – *by Saburo Matsui*

44 Multiple benefits through integrated end-use water management strategies – *by Robert C. Wilkinson*

◆ News ◆ Actualités ◆ Actualidades

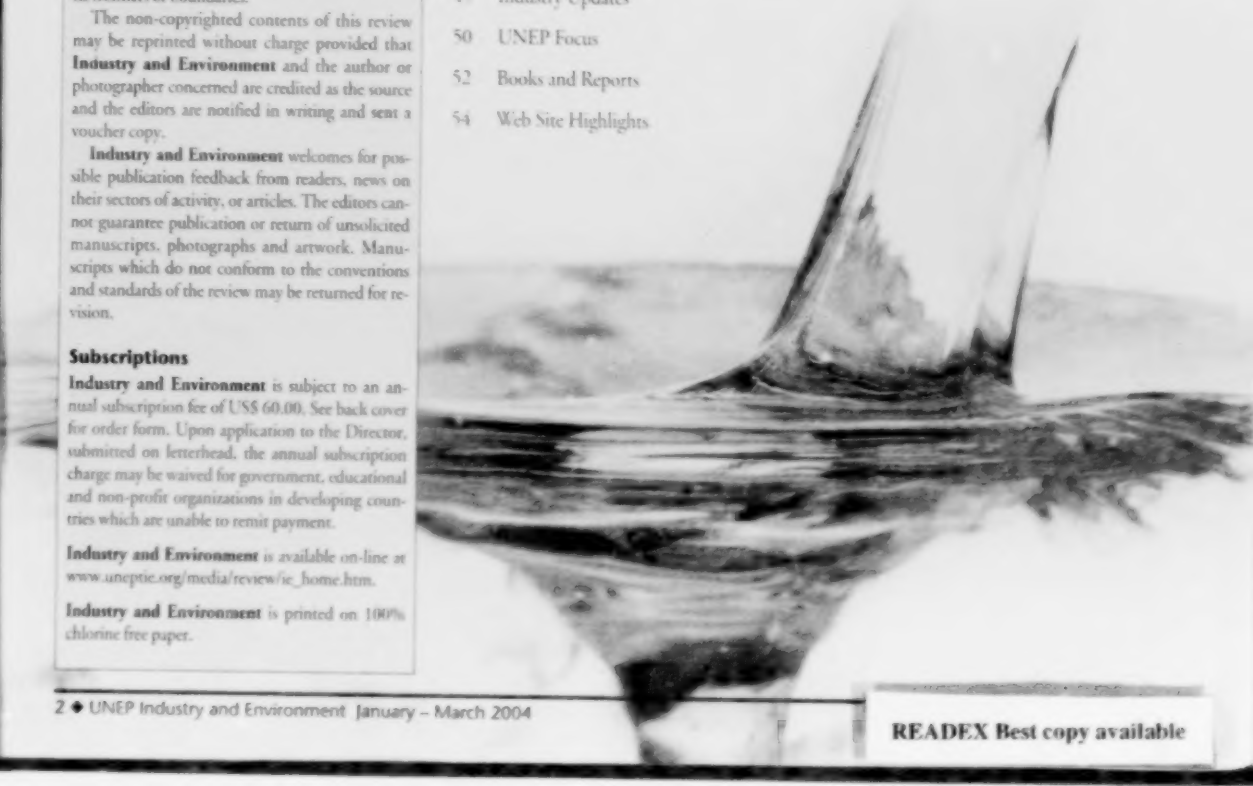
47 World News

49 Industry Updates

50 UNEP Focus

52 Books and Reports

54 Web Site Highlights



READEX Best copy available

The water business: commitments and opportunities

The global water situation, which many would call a water crisis, threatens development, the environment, and efforts to reduce poverty and assure peace.

In response to this threat, the international community has agreed to the targets of halving, by 2015 the proportion of the world's people who do not have access to safe water supply and to adequate sanitation.

Meeting these ambitious but critical commitments will require active engagement by business and industry worldwide. Work by companies – large and small –is needed in a sector that presents unprecedented challenges, but also countless opportunities. This will entail a renewed focus on "the water business."

There are many business challenges and opportunities in the water industry itself, that is, the provision of water and sanitation services. Major private sector water companies have recently demonstrated their reluctance to invest in developing countries. Debates concerning the nature of water – public good or economic good? – and fears relating to the impact of globalization have contributed to this reluctance.

Because of the scale of investment required to provide water and sanitation for the world's poor, private involvement and new forms of public-private partnerships are urgently needed. Many examples exist of successful partnerships involving local government, private companies and community organizations. With innovative financing, private companies large and small can discover further opportunities in the water sector.

Technology development is another area that presents opportunities for entrepreneurs and investors. The market for water-saving and pollution abatement technologies is attracting growing interest. Demand for devices such as ultra-low-flush and waterless toilets, drip irrigators, water meters and decentralized water treatment systems is increasing. The types of technologies required range from the most sophisticated high technology to small-scale, low-cost, low-tech devices – with an overall emphasis on user-friendliness and accessibility.

Small run-of-river hydropower plants, other technologies associated with renewable energy, and even energy efficiency and conservation technologies that may not seem directly related to the water sector should be included on this list. The relationship between energy and water is of course extremely close. The water sector is a large energy user. Water demand by the energy industry is second only to that of agriculture in many countries. Not only do over a billion people lack access to improved water supply, and 2.4 billion to adequate sanitation, but some 2 billion people do not have access to modern energy – another key constraint on development. The international community (including industry) has an interest in ensuring that sustainable energy sources are available. In many if not most cases, this means taking efficiency of water use into account.

Challenges and opportunities for business in the water sector should be examined bearing in mind the principles of cleaner production, including water and energy efficiency and conservation. Sustainability needs to be the fundamental principle underpinning all private and public efforts in this sector. No matter what form a company's role in addressing the world water crisis may take, that company should first ensure that its own operations are sustainable – not least because of proven benefits with respect to the bottom line.

While this issue of *Industry and Environment* principally addresses freshwater issues, it is important to note that fresh, coastal and marine water resources issues are intrinsically linked. It is increasingly recognized that water management can no longer rely on short-term approaches in which groundwater, rivers, lakes, coastal areas and marine waters are dealt with as separate entities. Global climate concerns are another factor, as unsustainable land use and water management increase the vulnerability of human health and the environment to extreme weather.

Industry's various roles in the water sector should be seen in the context of international recognition that good water management entails an integrated, ecosystem-based approach – one that encompasses water, sanitation and human settlements. This approach covers a wide range of goals and actions, including mitigating the impact of urbanization on water ecosystems, providing ecologically sustainable water supply, and taking a holistic view of sanitation that covers waste water collection, treatment, reuse and reallocation to the natural environment.

This integrated approach will benefit from the involvement of the private sector, as well as support by donors of development aid. It will also depend on innovative, proactive financing mechanisms such as project development facilities, revolving funds, and compensation for water-linked environmental services. Another essential element will be partnerships of governments, local communities, the private sector and other stakeholders. The importance of good governance in this regard cannot be overemphasized: great progress is being made, but in many countries the legislative and policy framework does not yet support efficient and equitable allocation and use of water resources.

The 23rd session of the UNEP Governing Council/Global Ministerial Environment Forum – meeting in Korea in March 2004 – will include a review of UNEP's water policy and strategy. In April 2004 the 12th session of the Commission on Sustainable Development will also be devoted to water and sanitation, specifically a review of the status of implementation of the global water agenda.

In the context of that global agenda, the articles in this issue of *Industry and Environment* examine the challenges and opportunities for business, the role of policies affecting water and other sectors, the contribution of technology, the need for community involvement, and special topics such as dams, the challenge in Africa, and the impact of global warming on risk management.

◆

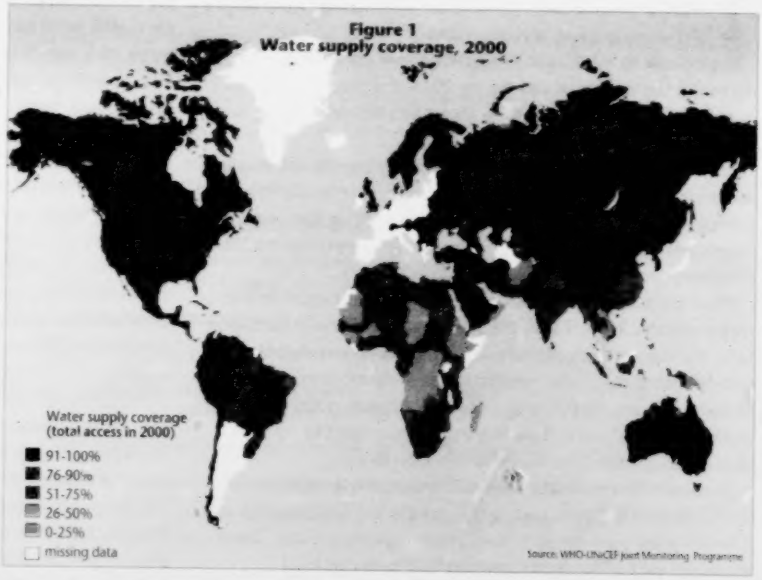
Freshwater and industry: facts and figures

The International Year of Freshwater, 2003, is now over. Work to increase access to safe drinking water and to improved sanitation nevertheless continues. These "Facts and Figures" do not include background for all of this work. They focus on the topic "freshwater and industry" – including provision of freshwater *as* industry (e.g. the water services and bottled water industries), water use by industry, the impact of industrial discharges on water resources, and some of the associated opportunities (and challenges) for industry.

In any discussion of industry's role with respect to water, two key figures must be borne in mind: 1.1 billion people in the world do not have access to improved water supply, and 2.4 billion do not have adequate sanitation (**Figures 1 and 2**).[1] Lack of water and sanitation on this scale jeopardizes human health and economic development. The international community, including industry, has pledged to halve the proportion of those who lack water and sanitation worldwide by 2015.

Most estimates of the funds needed worldwide for water supply and sanitation are between US$ 20 billion and US$ 55 billion a year. (Just for comparison's sake, some US$ 17 billion per year is spent on pet food in the US and Europe, and Europeans spend around US$ 105 billion on alcoholic drinks.) Bridging the water and sanitation gap will require up to twice the amount currently being invested in the water supply and household sanitation sector.[2] Estimates generally do not cover the environmental costs of waste water treatment.

Figure 1
Water supply coverage, 2000



Increasing water scarcity is compounding the problem. Within a few decades, around one-third of the global population is likely to experience chronic water shortages.[3] The world population of 6 billion already withdraws 54% of the total freshwater accessible from rivers, lakes and aquifers. At current population growth rates, population increases alone could push this share to 70% by 2025. However, there are indications that per capita water use is growing more rapidly than the population. Climate change will further exacerbate water shortages; according to one estimate, population growth and economic development will account for 80% of the global increase in water scarcity and climate change for the rest.[4]

Population growth in the next 20 to 50 years is expected to occur mainly in arid areas, and mainly in cities.[5] Even today only half of the world's city dwellers have water connections. To meet the international targets for water supply and sanitation just in urban areas will mean providing coverage to over a billion additional people by 2015.

In Africa (both rural and urban) meeting the targets for 2015 will mean adding 350 million additional people to water supply networks and 363 million to sanitary systems.[6] According to one estimate, to meet the worldwide sanitation target coverage would need to be provided to 400,000 more people per day.

Table 1
Annual per capita water use by region (cubic metres)

North America	1280
Europe and Australia	694
Asia	535
Latin America	311
Africa	186

Source: World Resources Institute

Developing countries currently spend 0.4% of their average GDP on water supply.[7] The World Bank has calculated that these countries spend US$ 80 billion per year on all water-related investments, with 90% of funds coming from domestic sources.[8] Equivalent figures from USAID are US$ 75 billion and 83%.[9] Most of the figures presented here are rough estimates – which is not surprising, given the magnitude of the need and the extended periods under discussion.

Overall, the poor pay must often pay between ten and 100 times more than the rich for the water services available to them.

Water supply

Most of the world's water supply is provided by national and municipal governments, especially in developing countries. Private companies serve

Harvesting rainwater

An ancient technology is being reinvented in many countries as a water supply solution. The latest rainwater harvesting techniques feature improved collection, storage and hygiene. Often very old cisterns, tanks and other such structures can be incorporated into modern rainwater collection systems.

A key advantage in rainwater harvesting is that practically anyone can do it, making it particularly suited to action by local communities. At the same time, care must be taken that too much water is not collected since runoff is needed to replenish rivers and groundwater supplies.

India is a leader in the promotion of rainwater harvesting. Its Centre for Science and Environment publishes an urban rainwater harvesting manual that was recently launched in five regional editions, in Hindi, Telugu, Marathi, Tamil and Gujarati (see www.rainwaterharvesting. org)

around 7% of the world population (slightly over 400 million people). The share of private water supply varies considerably from one country to the next, e.g. 100% in the UK but only 50% in Spain. In France, municipalities control the water sector but most water provision is contracted to private operators. Almost all water is supplied by public utilities in the United States.

The world's largest private water companies are Suez's Ondeo, Vivendi's Veolia, and Bouygues's Saur (France); RWE's Thames Water and American Utilities (Germany, UK, US); and Bechtel-United Utilities (US, UK).

Until fairly recently the private sector had been expected to expand in developing countries. Between 1990 and 1997, private sector capital spending on water supply and sanitation in developing countries was US$ 25 billion, compared with US$ 297 million in 1984-90. Most of this investment was in Latin America and Asia. Africa received less than 1% of the total.[10]

Large companies have been retrenching lately, reducing their exposure in the developing world and expressing concern about the financial viability of servicing the poor in countries whose governments cannot guarantee payment. The private sector's total share of water services is not expected to grow significantly in the next ten years or so.

Two-thirds of the world's available water resources are underground. Groundwater accounts for around half of water withdrawals. One-third of the world population (2 billion people) depends on groundwater supplies.[11] According to one UN estimate, the real cost of water worldwide would be 20 times higher if all water supply were based on treated surface water.[12] Groundwater is protected from much surface pollution, but it can be contaminated by, for example, saltwater infiltration and leachate from landfills.

Many aquifers are being drawn down faster than they can be recharged. The greater Mexico City metropolitan area (population 22 million) obtains 80% of its water supply from the Mexico Valley aquifer, which is being depleted. The land is therefore shifting, and Mexico City itself is sinking. The huge Ogallala aquifer in the midwestern United States is being used up eight times more rapidly than the recharge rate. Illegal tapping of groundwater is a problem in India and other countries. In parts of the Middle East, the groundwater being extracted is non-renewable "fossil" water.

Countries with regional water imbalances often undertake major projects designed to move water supply where the demand is. These projects usually include dams, canals and aqueducts. In November 2002 the government of China approved the largest such project in history, which would transfer water from the Yangtze River to the Yellow River basin. A preliminary estimate of the cost is US$ 50 billion.

As a result of dam building throughout the world, nearly 200,000 square miles of surface reservoirs store over 1400 cubic miles of water.[13] Around 20,000 large dams have been constructed in China. Japan has dammed all but about 10% of its rivers.

Figure 2
Sanitation coverage, 2000

Table 2
Water pollutants by industrial sector

Sector	Pollutants
Iron and steel	Organic residues, oil, metals, acids, phenols and cyanide
Textiles and leather	Organic residues, suspended solids, sulphates and chromium
Pulp and paper	Organic residues, solids, chlorinated organic compounds
Petrochemicals and refineries	Organic residues, mineral oils, phenols and chromium
Chemicals	Organic chemicals, heavy metals, suspended solids and cyanide
Non-ferrous metals	Fluorine, suspended solids
Micro-electronics	Organic residues, organic chemicals
Mining	Suspended solids, metals, heavy metals, acids, salts

Industries and their demand for water have grown at a very fast rate from the 20th century up to the present, posing a great threat to water quality.
Source: Water for People, Water for Life

History of water supply

The earliest known central water supply and waste water disposal dates back to the Sumerians, some 5000 years ago. Roman engineers built a water supply system that delivered nearly 500 million litres daily through aqueducts for almost five centuries. Greece, Carthage and Egypt also had public water supply systems.

Water supply's renaissance began in the 17th century, when Sir Francis Bacon experimented with water purification methods and the Italian physician Luc Antonio Porzio developed a multiple filter using sedimentation and straining followed by sand filtration. In the next century a Parisian scientist was granted the first patent for a filter design, using sponge, charcoal and wool. By this time the relationship between disease and dirty water had begun to be established, providing an impetus for such research.

The first facility delivering water to a town was built in Paisley, Scotland, in 1804. Its developer was the owner of a bleach works, John Gibb, who sought first and foremost to supply his business. Paisley was also the site of the first municipal water filtration works, opened in 1832.

In Paris, a water treatment plant with horse-driven pumps began operating in 1806. The water was settled for 12 hours, then run through sand and charcoal filters that were replaced every six hours.

Some of the world's earliest private water companies were set up in France, the first one more than a century and a half ago. Napoleon III established Générale des Eaux, predecessor of today's Veolia, in 1852, and Lyonnaise des Eaux, forerunner of Ondeo, was set up in 1880, sponsored by the Crédit Lyonnais bank. (Local government is also involved in the French water sector, however; the country's 16,000 public and private water supply utilities are under municipal authority, with private companies supplying more than 75% of customers.)

Water treatment made great strides in the second half of the 19th century with the development of rapid sand filters, improved slow sand filters and the first use of chlorine and ozone for disinfection. The United States and Canada use more than 79,000 short tonnes of chlorine per year in water treatment.

Nevertheless, half the world's population still has water services inferior to those available to the ancient Greeks and Romans.

Main source: www.auwa.org

Redistribution of natural flows, carried out in part to redress supply imbalances, has not only had environmental and social consequences (see below) but has even changed the Earth's orbital characteristics to a measurable extent.[14]

The World Bank invests about US$ 3.4 billion per year, or around 16% of its loan book, in water-related sectors and expects to increase this share.[15] Large dams account for around 10% of the Bank's loans.

Other work to increase water supply relies on technologies such as desalination and tertiary waste water treatment. Some 13,600 desalination plants of all types, including experimental ones, are in use in over 120 countries. These plants include over 7500 installations (most of which are in the Middle East) that turn seawater or brackish water into drinking water for public supply.[16] Desalination to produce drinking water costs about twice as much as conventional water treatment overall.

Purified waste water, also relatively expensive to produce, supplements conventional water resources in several countries. In Singapore's NEWater programme, for example, "used water" undergoes stringent treatment processes (including microfiltration, reverse osmosis and ultraviolet treatment). It is then blended with reservoir water, which undergoes conventional water treatment to become drinking water. In the United States, the Orange County Water District in California has injected purified waste water into aquifers since 1976 and the Upper Occoquan Sewage Authority in Virginia has discharged reclaimed waste water to the Occuquan Reservoir (which serves the Washington, DC metropolitan area) since 1978.[17]

Table 3
World and regional water use by sector and income group

	Agricultural use (%)	Industrial use (%)	Domestic use (%)
World	70	22	8
Low income	87	8	5
Middle income	74	13	12
Lower middle income	75	15	10
Upper middle income	73	10	17
Low and middle income	82	10	8
East Asia and Pacific	80	14	6
Europe and Central Asia	63	26	11
Latin America and Caribbean	74	9	18
Middle East and North Africa	89	4	6
South Asia	93	2	4
Sub-Saharan Africa	87	4	9
High income	30	59	11
Europe Economic and Monetary Union (EMU)	21	63	16

Source: Water for People, Water for Life

Water demand

Every year agriculture accounts for some 70% of water withdrawn worldwide for human use. Industry accounts for 22% of this water and household use for about 8%. In Africa the respective shares are 88%, 5% and 7%; in Europe they are 21%, 63% and 16%. In high-income countries industry accounts for 59% of total water use, while the share in low-income countries is only 8%[18]. Water consumption varies considerably according to region (**Tables 1 and 3**).

Agricultural demand is expected to increase substantially due to population growth. Much of the additional food needed is likely to come from irrigated land. While agriculture will probably remain the largest user of freshwater for the time being, OECD projections to 2020 indicate that industry will be the fastest growing water user, reflecting rapid industrialization in developing countries.[19]

Non-residential water use accounts for 53% of total water supplied by community water systems in the United States. Of that volume, over 70% goes to commercial, industrial and institutional users.[20]

Water is an essential raw material for much of industry, even if the amount used in different industrial processes varies dramatically. For example, it takes 9 litres of water to produce the average daily newspaper and 450,000 litres to produce the metal used in one car.[21] Since the mid 20th century the amount of water used in steel production has been reduced around tenfold.[22]

In 1995 industry was reported to use 752 km^3 of water per year worldwide. By 2025 this figure is expected to reach 1170 km^3 and industry is expected to account for about 24% of world freshwater withdrawal.[23]

Service sector water use, often lumped with household statistics, is considerable in certain subsectors. People who stay in luxury hotels, for example, use up to 800 litres of water per day, compared with the 300 litres per day used by the average tourist in Europe (or with normal household water demand of 131 litres in developed countries and 70 litres in developing countries).[24] An 18-hole golf course can consume over 2.3 million litres per day.[25]

Water and the energy industry

There is considerable interaction between the energy and water sectors. For example, 2-3% of world energy use is for pumping and treating water for urban residents and industry. In the case of developed country municipal water systems, energy is

The bottled water industry

Global consumption of bottled water is increasing by an average 12% a year, and the bottled water industry, worth more than US$ 35 billion, is growing 20% a year. With annual volume of nearly 100 billion litres, bottled water is the most dynamic part of the food and beverage industry.

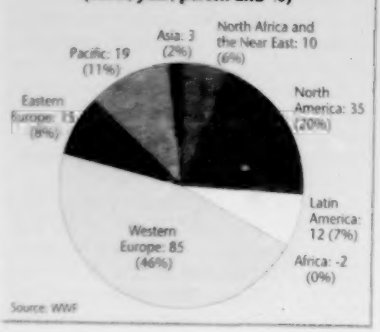
In the rich world, bottled water is perceived as being safer and of better quality than tap water, though this is not always necessarily the case. In the poor world, it is sometimes the only drinking water available. People spend up to 1000 times more for bottled water than for tap water.

The types of water bottled are natural mineral water (still or sparkling), spring water, purified water (which accounts for half of the world market by volume), and artesian and other well water.

Global per capita consumption is 15 litres a year. Western Europeans drink nearly half of the world's bottled water, averaging 85 litres per person per year. Asia and the Pacific is the most promising market: consumption there rose 15% a year over 1999-2001.

The Beverage Marketing Corporation reports that the world's top bottled water companies, by market share (based on total estimated 1999 wholesale dollar sales), are: Perrier with 28.9%, Suntory at 9.2%, McKesson at 7.6%, Danone with 7.2% and Pepsi-Cola at 5.5%. Local companies, however, control three quarters of the world market. Bottlers pay spring owners less than ten US cents a gallon.

World bottled water consumption, 1999 (litres/year/person and %)


Asia: 3 (2%)
North Africa and the Near East: 10 (6%)
Pacific: 19 (11%)
Eastern Europe: 13 (8%)
North America: 35 (20%)
Latin America: 12 (7%)
Africa: -2 (0%)
Western Europe: 85 (46%)

Source: WWF

The industry's environmental impacts stem mostly from packaging and transport. Plastic bottles are made from non-renewable oil and natural gas. More than 1.5 million tonnes of plastic per year is used to bottle water. PET, the type of plastic used for plastic water bottles, requires less energy to recycle than glass or aluminium and releases fewer emissions into the atmosphere. But the processes used to make plastics can cause serious pollution if unregulated. And most plastic bottles, instead of being recycled, are piling up in landfills, where, because of their slow rate of biodegrading, they will remain for hundreds of years.

One-fourth of the water bottled worldwide is consumed outside the country of origin, giving rise to greenhouse gas emissions in transport; however, 75% of the water is distributed regionally.

Main sources: Beverage Marketing Corporation, and www.wateryear2003.org

typically the second highest cost after labour.[26]

In turn, the energy industry is generally second only to irrigation with respect to water consumption in the developed world. Over 50% of freshwater abstraction in at least eight OECD countries is attributable to use of freshwater for cooling in electricity production. The OECD expects water withdrawal for energy use to nearly double worldwide in the period 1995-2020.[27]

More specific examples abound. Oil sand deposits in northern Alberta province are Canada's largest energy resource, equal to more oil than Saudi Arabia's reserves. Roughly three barrels of water are needed to produce a barrel of oil sand product. One of the main obstacles to use of steam to make the oil sands exploitable is the water crisis faced by this province.[28]

Hydropower is the most widely used renewable energy source, representing 19% of world electricity production. There is the potential to double this share, mainly in developing countries. However, environmental and social concerns have made dam building increasingly controversial.

Many of the 45,000 or so large dams operating worldwide were built to provide hydropower. The world's dams have inundated over 400,000 km² of land (much of it productive) and displaced between 40 million and 80 million people, as well as disrupting ecosystems. Moreover, the World Bank reports that construction cost overruns on the hydropower projects it has funded since the 1960s have averaged 30%. Another World Bank study found that in the case of almost one-third of hydro projects completed in the 1970s and 1980s, costs exceeded estimates by 50% or more. Reasons for cost overruns include delays, design

Table 4
Metering in single-family apartments connected to public water supply (OECD countries)

	Year	Metering penetration in:		
		Single-family houses	Individual apartments(1)	All individual households
Australia	1998	95-100%	"insignificant" (2)	n.a.
Austria	1998	100%	"very few" (3)	n.a.
Belgium	1997	90%	"many cases"	n.a.
Canada	1998	55%	"few"	n.a.
Czech Republic	1998	100%	n.a.	n.a.
Denmark	1996	64%	1% in Copenhagen	n.a.
Finland	1998	100%	"very low"	n.a.
France	1995	100%	>50%	88%
Germany	1997	100%	10-20%	55-60%
Greece(4)	1998	100%	100%	100%
Hungary	1998	100%	n.a.	n.a.
Iceland	1997	0%	0%	0%
Ireland	1998	0%	0%	0%
Italy	1998	90-100%	"many examples"	<30%
Japan	1997	100%	94%	100%
Korea	1998	100%	100%	n.a.
Netherlands	1997	93%	n.a.	n.a.
New Zealand	1997	25%	n.a.	n.a.
Norway	1998	"low"	0% or "very low"	10-15%
Poland	1998	100%	0%	"about 10%"
Portugal	1998	100%	n.a.	n.a.
Spain(5)	1998	"nearly 100%"	"nearly 100%"	95%
Sweden	1998	100%	0%	"about half"
Switzerland	1998	100%	0%	n.a.
Turkey(6)	1998	"nearly 100%"	"nearly 100%"	>95%
United Kingdom:				
• England and Wales	1998	12+%	"a few"	11%
• Northern Ireland	1997	0%	0%	0%
• Scotland	1997	"near 0%"	"near 0%"	0.002%
United States	1997	90+%	n.a.	n.a.

n.a. = not available.

Notes:
1. Applies to cold water metering; hot water provided in apartments via district heating is normally metered, but even here the practice varies widely.
2. "Insignificant" in Sydney only; the situation elsewhere is unknown.
3. More precisely, "perhaps about 20" apartment buildings in Vienna have individual meters.
4. Athens only.
5. Barcelona only.
6. Ankara only.

Source: Improving Water Management: Recent OECD Experience

How sewage treatment works

The three main types of treatment for waste water are physical, chemical and biological:

- Physical treatment consists of processes such as membrane technologies (e.g. ultrafiltration and microfiltration), carbon adsorption, distillation, filtration, ion exchange, oil and grease skimming, oil/water separation, sedimentation, steam stripping and solvent extraction.
- Chemical treatment includes chemical oxidation, chemical precipitation, chromium reduction, coagulation, cyanide destruction, dissolved air flotation, electrochemical oxidation, flocculation, hydrolysis, and neutralization (pH control).
- Biological treatment includes nitrogen removal, bio-augmentation, activated sludge, extended aeration, anaerobic processes, rotating biological contactors, sequencing batch reactors and trickling filters.

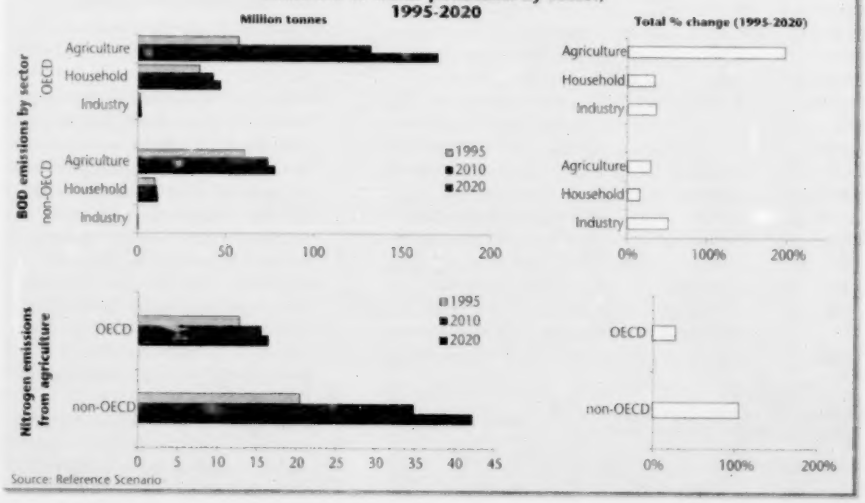
After preliminary treatment (screening out of debris and removal of grit), primary treatment typically uses clarification methods such as sedimentation and settling to remove about 60% of total suspended solids and 35% of organic matter (measured as biochemical oxygen demand or BOD). Next comes biological or secondary treatment. The biological process most often used in developed countries today is the activated sludge process, which utilizes microorganisms in an aerobic environment to remove most of the primary pollutants found in waste water.

The solids thus produced are removed and are often treated for recycling as fertilizer. In the United States more than half the six million short tonnes of sewage sludge generated every year (rechristened "biosolids") is used as fertilizer – more sludge than is disposed of through incineration, landfill and mine reclamation combined. The treatment generally includes a process to eliminate disease-causing organisms such as bacteria, viruses and parasites. Biosolids may also be treated with lime to raise their pH level so that they do not smell so bad.

If further treatment of the remaining waste water, such as nutrient removal, is required, tertiary treatment processes (both biological and chemical) can be used. The final effluent is disinfected (generally by chlorination/dechlorination, ultraviolet radiation and/or ozone treatment) before being released to rivers or injected into groundwater reservoirs.

Main source: www.wef.org

Figure 3
Emissions of water pollutants by sector, 1995-2020



Source: Reference Scenario

errors, poor construction quality and corruption.[29]

In addition to providing hydropower, dams can aid in flood control and irrigation. But their environmental impacts can include silt blockage and related soil erosion, ecosystem disruption, and emissions of greenhouse gases from flooded vegetation. Some environmentalists argue that since dams are not permanent, hydropower should not be considered a truly renewable form of energy.

Environmental impacts of water use

Over half the world's major rivers, and many of its coastal marine areas, are seriously polluted. Sources of pollution include untreated sewage, agricultural runoff and chemical pollution. In general, water pollution comes either from "point sources" (stationary locations such as sewage treatment plants, factories and water-going vessels) or "non-point" or "diffuse" sources such as agricultural runoff, mining and runoff from paved roads.

Although diffuse pollution from industry contributes to overall water pollution, the two main areas of concern to be examined here involve point-source pollution: industrial discharges (**Table 2, Figure 3**) and sewage, also called waste water.

It has been estimated that industry worldwide releases some 300-500 million tonnes of heavy metals, solvents, toxic sludge and other waste to waterways per year. (Releases of toxic chemicals alone in 1990 were estimated at 90 million tonnes.)[30] Factories that use organic raw materials are the most significant contributor to the load of organic pollutants, above all in the food sector (whose share of the load is 40% in high-income countries and 50% in low-income ones). Industry's impacts also include thermal pollution and associated problems resulting from releases of heated water from facilities such as nuclear power plants.

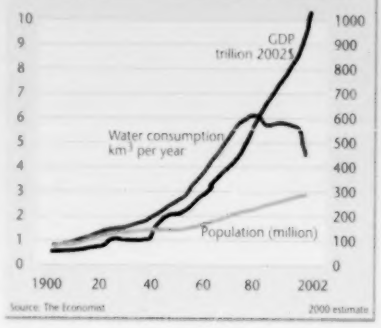
Many large public treatment systems require that industry treat its waste water to remove hazardous substances before it is sent to public treatment plant. In general, a combination of regulations and voluntary initiatives has resulted in significant reductions of industrial waste water volumes in much of the developed world.

Besides "planned" industrial releases, accidental discharges can have devastating effects on water resources. At Baia Mare in Romania, for example, the failure of an earth dam in 2000 sent tonnes of cyanide-contaminated gold mining slurry into the Tisza River and ultimately the Danube and the Black Sea.

The manufacturing and extractive industries are not the only sources of water pollution from business and industry. Service industries also contribute. The tourism industry accounts for about 7% of waste water pollution in the Mediterranean; on average a single tourist in that region generates up to 180 litres of waste water a day.[31] In the Caribbean region a 1994 study found that 80-90% of sewage from hotels and related tourism facilities was released without adequate treatment.[32]

Such discharges of untreated waste water, whether industrial or from households, to freshwater and coastal waters are a major threat to public health, livelihood and ecosystem functions, especially for many of the world's poor. The World Bank has estimated that only about 10% of household sewage is collected in developing countries, while some 90% of existing treatment plants do not operate reliably and efficiently.[33]

Figure 4
US GDP, population and water consumption



Source: The Economist

Solutions and outlook

In 1965 Japan used nearly 50 million litres of water to produce a million dollars' worth of commercial output. By 1989 its water productivity had nearly quadrupled, to 13 million litres per million real dollars of commercial output.[34] **Figure 4** shows a similar phenomenon in the United States, which uses water less efficiently than any other country. Systems for water recycling or reuse, as well as in-plant water treatment systems in industry, have contributed to these improvements.

The reverse side, as it were, of the two key figures cited at the beginning of this article is also revealing: yes, more than a billion people still lack access to modern water supply, but the percentage of people worldwide who have such access rose from 78% in 1990 to 82% in 2000. The percentage of the world's people with access to improved sanitation facilities rose from 51% to 61% over the same period.[35] The improvement in coverage occurred largely in rural areas.

The positive trends indicated by these examples, however, are not enough to meet the international targets for improving access to water and sanitation. In addition to efforts directed towards the key issue of agriculture (by one estimate, improving the efficiency of water delivery for irrigation by 10% could double the amount of drinking water available worldwide[36]), major shifts in industrial and economic policy and technology are being sought.

Market mechanisms, especially pricing, are increasingly being considered. While the question of whether to treat water as a public good or an economic good remains a source of contention, there is fairly wide agreement that water service suppliers should charge rates that cover their overall costs. It is also generally accepted that charges for at least basic water services (including sewerage) should be affordable to all income groups. Metering of individual households' water use (**Table 4**) is seen as vital in many countries but, partly because of the initial costs, is controversial in others. Increasingly, water policy makers are learning which components of water service charges (e.g. connection charges, volumetric charges, fixed charges) can best be used to reach various policy objectives.

Concerning industrial water discharges, there is a trend in developed countries towards separat-

ing water use charges from waste water charges. Only a few OECD countries still include the costs of industrial sewerage services in the price of water supply or in general local taxes.

The emphasis in waste water treatment approaches, especially as regards developing countries, is increasingly on low-cost, environment-friendly alternatives to large centralized treatment plants; these include eco-technologies such as constructed wetlands.

Water management tools are being developed to help industry reap the benefits of water conservation. One example is the Water Sustainability Strategy Tool developed by the Global Environment Management Initiative, an industry organization based in Washington, DC, whose 39 members are mostly multinational companies.[37]

The potential contribution of recovered waste water to water supply is mentioned above. Tourism is an area where water reclamation can be particularly effective. Related approaches such as ecological sanitation also hold considerable potential.[38] Public education campaigns would be essential to promote acceptance of such methods.

Improvements and investments in water transfer systems (pipes, etc.) in use have reduced water leakage rates from municipal systems to as low as 10-12% in some countries (in many places around half of all water piped is lost to leaks).

Waste management policies are also important; solid waste, especially when improperly disposed of, is the main source of water pollution worldwide.[39]

More innovative approaches include the "virtual water" movement. The World Water Council and other organizations are campaigning for recognition that the water used to produce the goods a country imports would otherwise have to be supplied in that country; effectively, trade in virtual water allows water-poor countries to import high water consuming products while exporting low water consuming products, and thus make water available for other purposes. One way of looking at global trade in agricultural products is as trade in virtual water.[40]

Innovation is also being sought as regards the mechanisms for financing the investments needed in improving water and sanitation services. Current approaches include international and bilateral funding, debt relief, private-sector participation programmes, micro financing, revolving funds and community-level resource mobilization.

About the references

In addition to those listed below in the notes, two sources were indispensable in the compilation of this article: "Priceless": a survey of water, *The Economist*, 17 July 2003 (www.economist.com); and www.wateryear2003. org (the official site of the International Year of Freshwater). Information for which no reference is given here was found in these sources, which in turn drew upon published and unpublished material.

Notes

1. WHO/UNICEF: *Global Water Supply and Sanitation Assessment 2000 Report*
2. OECD, 2003: *Improving Water Management: Recent OECD Experience*
3. UNEP, 2002: *Global Environment Outlook 3*
4. World Water Assessment Programme, 2003: *Water for People, Water for Life: The United Nations World Water Development Report*
5. Speers, A., 2003: "Water and industry: challenges and opportunities" (page 13 of this issue)
6. Shehu Yahaya, 2003: "Meeting targets for water supply and sanitation: the African challenge" (page 22 of this issue)
7. *The Observer* (London), 16 March 2003: "Left high and dry by the water companies"
8. *Ibid.*
9. USAID et al., 2002: *Energy and Water for Sustainable Living: A Compendium of Energy and Water Success Stories*, limited distribution CD-ROM
10. Thompson, J. (2001): "Private Sector Participation in the Water Sector: Can It Meet Social and Environmental Needs?" International Institute for Environment and Development, London
11. World Water Assessment Programme, *op. cit.*
12. United Nations Economic Commission for Europe, 2003: "Regional implementation forum on sustainable development"
13. Hawken, P. *et al.*, 1999: *Natural Capitalism. Creating the Next Industrial Revolution*, Little, Brown
14. *Ibid.*
15. *The Observer*, *op. cit.*
16. California Coastal Commission, 1993: "Seawater Desalination in California"
17. www.pub.gov.sg/NEWater
18. World Water Assessment Programme, *op. cit.*
19. OECD, *op. cit.*
20. Wilkinson, R., 2003: "Multiple benefits through integrated end-use water management strategies" (page 44 of this issue)
21. Speers, *op. cit.*
22 www.worldwater.org
23. World Water Assessment Programme, *op. cit.*
24. UNEP/DTIE, 2003: *A Manual for Water and Waste Management: What the Tourism Industry Can Do to Improve Its Performance*
25. World Water Assessment Programme, *op. cit.*
26. www.watergy.org
27. OECD, *op. cit.*
28. www.gasandoil.com
29. www.worldwater.org
30. www.awwa.org
31 UNEP/DTIE, *op. cit.*
32. World Water Assessment Programme, *op. cit.*
33. UNEP/GPA, 2003: "Financing Wastewater Collection and Treatment," background paper
34. www.worldwater.org
35. www.wssinfo.org
36. "Water-Wise: A Well Of Facts," fact sheet from US Agency for International Development, http://usinfo.state.gov/journals/itgic/0399/ijge/gj-07b.htm
37. *Tomorrow: Global Sustainable Business*, 2002: "Investing in our precious blue," Vol. 12, No. 3
38. Matsui, S., 2003: "Towards a new form of urban sanitation and water infrastructure" (page 41 of this issue)
39. UNEP/DTIE/IETC, 2002: *International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management*, www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/main_index.asp
40. www.worldwatercouncil.org

◆

Objectifs de développement du Millénaire, nouvelle gestion de l'eau, contribution du monde des entreprises et des affaires

Pierre-Frédéric Ténière-Buchot, Gouverneur du Conseil Mondial de l'Eau, Membre de l'Académie de l'eau (France).
Programme Solidarité eau, 32 rue Le Peletier, 75009 Paris, France (pftb@free.fr)

Summary
Within the context of the Millenium Development Goals for water, the Camdessus Panel's recommendations on financing water insfrastructure are summarized and commented on in this article, with an emphasis on relations between the public and private sectors. The situation regarding public-private partnerships leaves much to be desired, but it is not hopeless. Realistic proposals are made for improving matters.

Résumé
Après un rappel du contenu des objectifs de développement du millénaire pour ce qui concerne l'eau, un résumé des recommandations du Panel Camdessus est fourni, notamment du point de vue des relations entre secteurs public et privé. L'état des lieux de ces relations est ensuite dressé. S'il n'est guère brillant aujourd'hui, il n'est pas désespéré. Des conditions réalisables et des suggestions sont proposées pour dépasser les difficultés présentes.

Resumen
Dentro del contexto de los Objetivos de Desarrollo del Milenio relativos al agua, se sintetizan y comentan las recomendaciones del Panel Camdessus sobre el financiamiento de la infraestructura hidráulica, con un particular énfasis en las relaciones entre el sector público y el sector privado. El estado de cooperación entre ambos sectores deja mucho que desear, aunque no revela una situación crítica. Se presentan propuestas realistas para superar las dificultades actuales.

Les Objectifs de développement du Millénaire et l'eau

Des efforts particuliers ont été développés dans le monde en faveur de l'eau ces dernières années, notamment en 2002-2003, par l'ensemble des grands acteurs et décideurs de la politique de l'eau. On doit d'abord citer le rôle tenu par le Secrétariat général des Nations Unies et les 23 organisations et programmes des Nations Unies (au sein desquelles le PNUE). Parmi les divers Objectifs de développement du Millénaire (ODM) annoncés par l'Assemblée générale des Nations Unies au début de l'année 2001, puis repris et renforcés pour ce qui concerne l'eau à la Conférence mondiale sur le développement durable de Johannesburg en 2002, on peut retenir deux objectifs concrets et ambitieux pour 2015 :

- diminuer de moitié le nombre de personnes (un peu plus d'un milliard) n'ayant pas accès à l'eau (potable) ;
- diminuer de moitié le nombre de personnes (un peu moins de 2,5 milliards) qui n'ont aucun équipement d'évacuation et de traitement des eaux usées.

De surcroît, l'année 2003 a été déclarée « année internationale de l'eau ». Dans les années qui viennent, on en retiendra l'intéressante extension que le second objectif (ajouté lors de la conférence de Johannesburg) apporte au premier.

Faciliter l'accès à l'eau pour tous, reconnaître que cet accès est une forme de droit fondamental de la personne humaine revient à décliner juridiquement le slogan bien connu : « l'eau, c'est la vie ». En effet, sans eau pas de vie, et d'importants efforts restent à accomplir pour compléter les décennies de l'eau qui se sont succédées depuis les années 1970.

Mais l'innovation majeure, celle qui a influencée l'année internationale de l'eau, est l'ajout du second objectif. Cette nouveauté a très intelligemment été synthétisée par le ministre des eaux et des forêts d'Afrique du Sud, S.E. Ronnie Kasrils, qui a étendu le slogan : « l'eau, c'est la vie mais l'assainissement, c'est la dignité ». Dignité pour les plus pauvres, les plus isolés, les plus minoritaires. Dignité pour les femmes et les enfants, souvent les derniers bénéficiaires du progrès et de l'amélioration des conditions de vie. Amélioration aussi pour l'hygiène et la santé publique, pour l'environnement, enfin considéré autrement qu'en tant qu'exutoire de tous les déchets des activités humaines.

Pourquoi avoir limité ces deux objectifs mondiaux de l'eau à seulement la moitié des besoins qui sont connus et bien analysés ? Parce qu'ils représentent une dépense très importante (grosso modo, doubler chaque année les dépenses pour l'eau qui sont consenties aujourd'hui) ; ensuite parce qu'il a paru sage de choisir un horizon temporel restreint (moins de quinze ans) afin de rester réaliste et crédible.

Si jamais les objectifs du millénaire étaient réalisés à temps pour ce qui concerne l'eau, il conviendrait bien entendu de poursuivre cet accroissement de l'effort jusqu'en 2025 probablement, en vue d'achever ces impératifs pour l'ensemble de la population mondiale. On rejoindrait ainsi la satisfaction de critères d'un développement véritablement durable, c'est-à-dire tenant compte de toutes les conséquences des usages de l'eau.

Une gestion nouvelle de l'eau

Le concept de gestion intégrée des ressources en eau (GIRE) s'est peu à peu imposé à travers le monde, notamment grâce aux travaux du Global Water Partnership (GWP, Stockholm), créé par la Banque mondiale en 1996, qui met en présence des experts publics privés et associatifs (un exemple d'approche par la gouvernance).

En fait, ce modèle existait déjà depuis longtemps dans certains pays (en particulier en Europe : la GIRE est le cœur de la directive-cadre pour l'eau de l'Union européenne, de 2001). Il tend maintenant à se généraliser dans toutes les parties du monde. C'est un modèle global qui refuse la sectorisation des approches. Il n'est donc plus question d'avoir une politique de protection des ressources hydrauliques à côté d'une autre, le plus souvent totalement opposée, d'utilisation de ces mêmes ressources pour l'agriculture ou pour l'industrie, par exemple. De même, on s'efforce de ne plus distinguer les eaux souterraines des eaux superficielles : l'aménagement du territoire de la politique de prévention des risques naturels (inondations) ; les usagers publics (municipalités) des usagers privés (citoyens, industries, agriculteurs). Tout doit être vu et compris globalement.

L'eau doit faire l'objet de compromis négociés dans le cadre d'une approche « durable », c'est-à-dire consentie par tous. « Durable » est une mauvaise traduction en français du concept de « sustainability », d'acceptabilité de tous les intérêts en présence à l'occasion d'un compromis que l'on cherche à rendre viable.

Cette globalisation dans la recherche du compromis viable s'étend à tous les acteurs de l'eau : pouvoirs publics nationaux, régionaux, internationaux ; intérêts privés des entreprises qui tirent profit du marché de l'eau (éco-industries, éco-services) comme de celles qui sont clientes de ce marché ; enfin associations non gouvernementales et simples citoyens.

Très souvent les explications données sur la GIRE insistent sur les aspects scientifiques, techniques et sectoriels sans aborder les aspects institutionnels, juridiques, économiques, financiers et socio-politiques.

Ces dernières préoccupations ont fait l'objet d'une étude particulière et approfondie de la part d'un groupe de financiers réunis sous la direction de Monsieur Michel Camdessus, ancien directeur général du Fonds monétaire international. Cette étude, intitulée « Financer l'eau pour tous, rapport du Panel mondial sur le financement des infrastructures de l'eau » a été entreprise à l'initiative du GWP, déjà cité, et du Conseil mondial de l'eau (Marseille), une autre création de la Banque mondiale.

Le Conseil mondial de l'eau (World Water Council – WWC) a notamment la charge de patronner tous les trois ans le Forum mondial de l'eau qui réunit un très grand nombre d'acteurs et décideurs de ce domaine (1997 : Marrakech ; 2000 : La Haye ; 2003 : Kyoto ; 2006 : Mexico).

Le Panel mondial sur le financement des infrastructures hydrauliques (voir le rapport correspondant sur www.worldwatercouncil.org ou sur www.gwpforum.org) a insisté notamment sur les aspects suivants :

- Doubler les flux financiers de toutes origines en faveur des infrastructures de l'eau (eau potable, assainissement, irrigation contrôlée, hydroélectricité, protection contre les inondations, protection des ressources en eau et de l'environnement).
- Donner une plus grande priorité gouvernementale aux réalisations hydrauliques de toute nature, tout en favorisant la décentralisation des opérations (au niveau municipal ou local).
- Impliquer le secteur privé dans l'investissement et le fonctionnement des ouvrages de l'eau dans le cadre de la GIRE.
- Encourager le niveau infranational (régional, municipal, local), à recevoir des crédits sous-souverains, négociés à ce niveau et non plus au niveau national souverain.
- Promouvoir toutes les formes de participation entre secteurs public et privé en cherchant à favoriser celles qui ont le plus de succès en vue de banaliser ces pratiques.
- Créer un fonds permanent de soutien financier garantissant les opérations précédentes.
- Favoriser le recours aux marchés locaux, à l'épargne locale, et encourager l'usage au moins partiel de la monnaie locale grâce à la création de fonds de garantie correspondants. Ces dispositions devront être aidées et soutenues par les institutions financières internationales et autres agences financières impliquées dans le domaine de l'eau.
- Chercher à développer un équilibre financier acceptable pour aussi bien rembourser les emprunts qu'assurer l'amortissement et le fonctionnement des ouvrages hydrauliques réalisés. Tenir compte des possibilités contributives des divers usagers et institutions dans la répartition des charges et des prix.
- Développer les compétences de gestion (planification, financement de projets, opérations en participation) des organismes ayant la charge de la politique de l'eau.
- Agir en toute transparence vis-à-vis de l'opinion publique, des associations et organisations non gouvernementales en vue de développer une gestion éthique de l'eau.
- Doubler l'aide publique au développement en faveur de l'eau.
- Attribuer les aides aux opérations hydrauliques qui vont dans le sens de la réalisation des Objectifs de développement du Millénaire.
- Se servir de l'aide publique au développement comme catalyseur favorisant d'autres apports financiers publics et privés et chercher à développer des mécanismes de garantie avec le conseil et l'appui du Comité d'aide au développement de l'Organisation pour la coopération et le développement économiques.
- Soutenir les initiatives innovantes des divers donateurs ou organismes prêteurs multilatéraux comme par exemple l'aide conditionnée à l'obtention de résultats (Output Based Aid – OBA).
- Encourager la réforme des pratiques usuelles des institutions financières internationales en fonction des observations précédentes.
- Simplifier les dossiers d'instruction de financement pour l'eau présentés aux banques commerciales et chercher à développer des mécanismes de garantie mutuels s'étendant aux institutions financières internationales et aux agences de crédit export.
- Développer un mécanisme de protection contre les effets des dévaluations en vue de limiter les risques dans le domaine des investissements hydrauliques.
- Obtenir de meilleures conditions pour les opérations hydrauliques de la part des agences de crédit export telles qu'une proportion accrue des opérations aidées, des délais de remboursement plus longs, une prise en charge plus importante, des garanties et prêts en monnaie locale.
- S'assurer que les petits opérateurs locaux prestataires de services dans le domaine de l'eau ne sont pas oubliés mais, au contraire, encouragés notamment pour leur accès au crédit.
- Vérifier que le choix entre opérateurs publics et privés résulte de critères d'efficacité simples et transparents. Les mécanismes d'aide en place doivent pouvoir bénéficier indifféremment aux uns comme aux autres, quel que soit le choix effectué.
- Encourager les garanties gouvernementales à long terme permettant de sécuriser durablement les participations privées acceptées par les gouvernements.
- Soutenir les initiatives et actions des associations et organismes non gouvernementaux, les opérations de micro crédit et les mécanismes de solidarité tels qu'un fonds décentralisé pour des initiatives locales.
- Mettre en place un organisme de contrôle de l'avancement des Objectifs de développement du Millénaire dans le domaine de l'eau.

UNICEF

L'accès à l'eau est une forme de droit fondamental de la personne humaine

La contribution du monde des entreprises et des affaires

Les considérations et propositions précédentes mettent souvent en lumière le rôle important des entreprises et organismes privés, quelle que soit leur fonction dans le domaine de l'eau : technique, administrative, de conseil, financière ou autre.

Quelques constats et commentaires peuvent accompagner à cet égard la liste résumée des recommandations du Panel Camdessus.

Il est souhaité que le secteur privé (banques commerciales et organismes financiers spécialisés, entreprises et opérateurs) intervienne le plus possible et d'une manière concrète (investissements,

fonctionnement) dans le domaine de l'eau, au-delà des opérations de communication, de sensibilisation, de démonstration prototype qui parlent plus des solutions à apporter aux problèmes qu'elles ne les réalisent. Pour intéressantes qu'elles puissent être dans certains cas, ces opérations sont financièrement à l'échelle du millième ou moins le plus souvent, dans très peu de cas à l'échelle du centième des Objectifs hydrauliques de développement du Millénaire. En fait, elles ne constituent aucunement un engagement, c'est-à-dire la participation à un risque collectif mais seulement son apparence. Nul jugement ici, le secteur privé doit rester libre de ses décisions, mais seulement le rappel qu'il en va pour l'eau comme pour le reste, à savoir que dire n'est pas faire.

Faire intervenir massivement et non symboliquement le secteur privé dans le domaine de l'eau, en dépassant les limites des opérateurs professionnels actuels, est une orientation qui pourrait être suivie d'effets si certaines conditions préalables étaient vérifiées :

• Rappeler tout d'abord qu'il n'est pas question de privatiser l'eau d'aucune manière. C'est le secteur public, notamment local, qui assure la responsabilité de la politique de l'eau. Sous son autorité, les partenaires privés, prestataires, peuvent être associés sous diverses formes juridiques et financières qui, quelles qu'elles soient, ne sauraient faire confondre la personnalité privée des uns et publique des autres. Dans ce partage, chacun doit trouver son intérêt et notamment l'usager.

• Insister sur le fait que si le secteur privé est choisi, c'est pour des raisons vraisemblables et acceptables de meilleure efficacité technique, financière, ou encore de compétence spécialisée, toutes qualités qui doivent être démontrées de manière simple et transparente, sans qu'il soit utile d'avoir recours à l'idéologie. Les mêmes obligations et avantages, à l'échelle internationale, nationale ou locale doivent être requises ou apportés à l'attributaire des travaux ou opérations à effectuer, quel que soit son statut public ou privé.

• Les opérations qui sont risquées par le secteur privé doivent pouvoir être garanties à long terme, c'est-à-dire durant la période de construction et/ou d'exploitation, particulièrement longue dans le cas des ouvrages hydrauliques. Ces garanties peuvent prendre plusieurs formes selon les organismes internationaux, nationaux, locaux ou mutuels qui les assurent. Elles ont pour but de sécuriser les opérations au moins vis-à-vis des risques classiques de dévaluation et de changement politique. Il est probable que dans un avenir proche, l'absence de garantie dans le domaine de l'eau entrainera automatiquement l'absence d'opérateurs.

• Une dernière condition tient au fait que si le secteur public décide et le secteur privé réalise, une conduite éthique donnant lieu à un suivi et un contrôle indépendants et transparents doit pouvoir être observée vis-à-vis de l'un, que l'usager paie, comme de l'autre, qu'il élit. Ce mécanisme d'évaluation doit être mis en place en fonction du système de gouvernance dont s'est doté le pays où a lieu l'opération.

Toute forme d'association entre le secteur privé, les organismes publics et le secteur associatif est la bienvenue dans la mesure où elle facilite la transparence des opérations et répartit efficacement et honnêtement les risques et les avantages.

WWAP/G. MEYBRECHT

Qu'en est-il aujourd'hui du partenariat public privé dans le domaine de l'eau ?

Il faut d'abord faire remarquer que ce concept de partenariat, véritable pierre philosophale de la fin des années quatre-vingt-dix est beaucoup plus dû à la fertile imagination du secteur public international qu'à une volonté affirmée du secteur privé. Si l'intérêt pour acquérir une meilleure image, développer un marketing environnemental en animant de nouveaux marchés, donner une expansion aux secteurs de communication sont indéniables, force est de reconnaitre également que les activités du privé dans le domaine des infrastructures hydrauliques et de leur exploitation a régressé ces dernières années, sans pour autant que le secteur public prenne le relais.

Le secteur de l'eau est considéré désormais comme à la fois risqué et peu rentable. Les actionnaires sont là pour le rappeler.

Par ailleurs, la notion de secteur privé est peu populaire. L'ambiguïté du terme anglo-saxon de « privatization » a accompli ce que les détracteurs idéologiques du secteur privé et de l'internationalisation avaient de la peine à démontrer. Enfin, les cultures des deux secteurs se heurtent plus que ne se complètent : le privé veut gagner sans rien risquer, en tout cas le moins possible ; le public préfère, sans hésitation aucune, piétiner que de risquer une carrière toujours fragile. Les délais très longs – trop longs – des opérations hydrauliques ne font qu'accentuer ce paysage morose : dix ans ou plus séparent le moment où l'on conçoit un ouvrage du moment où il est mis en eau ; il faut encore ajouter cinq à dix ans pour atteindre le seuil de rentabilité. Par rapport aux standards financiers usuels, ces délais paraissent excessifs.

Le partenariat public privé est-il pour autant mort-né ? Peut-être pas si l'on accepte de voir la réalité en face (il est malade, il faut le soigner) et si l'on cesse de prendre une crise inquiétante (la mortalité et la morbidité dues à l'eau et au manque d'assainissement ne cessent de se développer depuis quinze ans) pour un résultat enthousiasmant de la pertinence de la politique de l'eau des uns, secteur public international et national, et des autres, secteur privé des grands opérateurs distributeurs. Tous ont échoué, l'espoir résidant dans le fait qu'il est désormais relativement facile de mieux réussir …

Que recommander en évitant les errements passés ?

• Continuer à sensibiliser la population, à enrichir les compétences, à améliorer les institutions et à développer leur capacité à entreprendre. Apprendre à raison garder dans ce domaine, nécessaire mais nullement suffisant : toutes ces activités ne produisent pas une seule goutte d'eau supplémentaire. La capacité à parler de l'art ne fait pas l'artiste.

• Définir des projets précis et bancables qui s'insèrent au sein d'une vision financière intégrée et négociée entre les divers preneurs de risque, plutôt que des programmes généraux et vagues, mélangeant le public et le privé sans désigner explicitement leurs représentants respectifs. Un contrat est un accord de volontés. On peut observer aujourd'hui une volonté de ne pas s'accorder. Pourquoi attendre des années que cet état de fait se modifie sans pour autant ne rien entreprendre ?

• Faire gérer les grands projets par un fonds particulier qui puisse générer de la confiance, quitte à mutualiser de tels fonds chaque fois que cela semble possible.

• Développer des mécanismes de suivi et de contrôle qui utilisent l'approche de la gouvernance, c'est-à-dire de la co-responsabilité et non celle de l'administration qui punit sans surveiller.

• Enfin, essayer par tous les moyens, sans en omettre aucun, de donner à l'eau le prix qu'elle mérite, deux à vingt fois le prix actuel selon les cas. Ce n'est pas cher payer quand il s'agit de la vie et de la dignité. Ce n'est pas non plus une charge bien lourde lorsqu'il s'agit de payer à la place de ceux qui ne le peuvent pas encore. ◆

Water and industry: challenges and opportunities

Andrew Speers, Programme Manager, Sustainability, International Water Association, 12 Caxton Street, London SW1H 0QS, UK (andrew.speers@iwahq.org.uk)

Summary

This article provides an overview of approaches to achieving more efficient water use by industry (e.g. pricing options, financial incentives, voluntary agreements, adoption of environmental management standards, cleaner production, "industrial ecology"). Anticipated changes in the water industry will reflect economic, environmental and social developments. Water supply, waste water generation and good business practice are identified as drivers for change. The need to consider urban areas and industrial facilities within their watersheds or catchments is emphasized.

Résumé

L'article donne un aperçu des méthodes employées pour inciter l'industrie à faire un usage plus rationnel de l'eau : options tarifaires, incitations financières, accords volontaires, adoption de normes de gestion environnementale, modes de production plus propres, écologie industrielle, etc. Les changements attendus dans le secteur de l'eau seront le reflet de l'évolution de la situation économique, environnementale et sociale. L'approvisionnement en eau, la production d'eaux usées et les bonnes pratiques d'entreprise sont ici considérés comme des moteurs de changement. L'auteur insiste sur la nécessité d'envisager les zones urbaines et les installations industrielles en les replaçant dans le contexte de leur bassin hydrographique.

Resumen

En este artículo se ofrece un panorama general de diversos enfoques para lograr un aprovechamiento más eficiente de los recursos hídricos en la industria (por ejemplo, opciones para fijar precios, incentivos financieros, acuerdos voluntarios, adopción de estándares ambientales de administración, producción más limpia o "ecología industrial"). Los cambios previstos en la industria del agua se verán reflejados en el desarrollo de la economía, del medio ambiente y del entorno social. Entre los factores que impulsan tales cambios destacan el abastecimiento de agua, la generación de aguas residuales y la ejecución de buenas prácticas de negocios. Se subraya la necesidad de tomar en cuenta las zonas urbanas y las instalaciones industriales dentro de sus cuencas hidrográficas o zonas de captación de riego.

Industrial development is fundamental to human quality of life. It provides employment opportunities, wealth creation, and goods and services that underpin conditions in the developed world, and that are of fundamental importance to the developing world. However, the means of production that generate these benefits also affect the environment, which is more important to human existence and the functioning of the planet in the long run than the production of any good or service.

This article presents an overview of conditions to which industry will need to respond in the future when it uses natural resources, particularly water. Examples are given of responses that could be made, ranging from incremental improvements to fundamental reappraisal of production processes. Industries need to be considered not only in their own right, but also as part of the catchments and ecosystems in which they exist. While the enterprises in the article might be classified as heavy industry, including manufacturing, many (if not all) of the lessons that can be drawn are applicable to commercial and service industries.

Historical conditions

Governments have regularly provided subsidies to industries or protected them during their formative stages. Such support has often included provision of virtually free water and permission for uncontrolled waste water discharges. An unpriced, unregulated good or service is consumed more rapidly than if a cost or penalty were associated with it. Hence, the volumes of water consumed by industry have historically been excessive.

The privatization of government enterprises, removal of protection, and changes in the labour market, especially in developed countries, have led to huge efficiency gains by industry. Pollution control laws have mitigated offensive, damaging or toxic discharges. Yet water frequently remains underpriced and its regulation remains a somewhat blunt instrument. The same level of efficiency gains has often not been achieved with regard to water consumption per unit of production, and environmental impacts are still unacceptable.

Whether or not governments see subsidized water and waste water services as a component of national industrial growth strategies – and even if water remains subsidized for other political reasons, or through simple lack of attention by policy makers – such conditions are unlikely to continue for several reasons. Some of these reasons are economic, some are environmental, and some are social.

Drivers for change

Water supply

It is increasingly recognized that water is not a limitless resource. Basic economics dictates that something in limited supply needs to be rationed. Water is superabundant on the planet as a whole, but fresh potable water is not always available at the right time or the right place for human or ecosystem use. Whether through regulation or market forces, governments will have a role in "rationing" water supplies.

Moreover, there is increasing awareness that anthropocentric uses of water are damaging ecosystems. Overuse of rivers and aquifers has had serious environmental consequences, many of which are only now being recognized and quantified. Projects to mitigate these consequences are emerging. One result of such projects will often be to reduce the volume of water ultimately available to urban areas.

In Australia, for example, a decision was reached recently to release additional water from the country's major hydroelectric project to restore flows to the Snowy River, which has been significantly depleted since the project was commissioned in the 1950s. The Snowy flows through a primarily rural area, with only scant industrial use. However, to improve the ecology of Australia's Hawkesbury-Nepean system, it is likely that a 20% increase in the volume of water released from Sydney's major supply system will be required. Thus Sydney, which has more or less abandoned plans for new reservoirs due to community resistance, will have to conserve water more aggressively so that flows can be shared with the environment. Industry clearly has a role to play in achieving these conservation targets.

Population growth in the next 20 to 50 years will mainly occur in arid areas and will mainly be urban. Industrial enterprises will be needed to support the economy of major new urban areas in dry zones. Yet providing these enterprises with the quantity and quality of water available in most industrialized economies will simply not be possible. Community resistance to new dams and reservoirs is nearly universal. Even where such projects are carried out in countries without effective

community action groups, local resistance to the flooding of new valleys is such that the projects are criticized on social, environmental and economic grounds by the international community.

Waste water generation

To the above water supply constraints must be added emerging limitations on discharges of industrial waste water. The economy of the Mesquital Valley, south of Mexico City, supports a million people where the sole water resource available is essentially untreated waste water from Mexico City. As farmers are reported to have said: "The waste water builds the soil" (providing water and nutrients for growing non-food crops). Nevertheless, the presence of industrial contaminants, both organic and inorganic, is a limiting factor. In such situations in developing countries, consideration is being given to separating industrial and household waste water flows to protect the quality of the "resource" or reduce the environmental impact.

Similarly, in areas where waste water is not yet seen as a resource, industrial waste water is recognized as a major contributor to environmental degradation in receiving waters. Thus there is pressure on industrial dischargers to reduce contaminant discharges, and on utilities to improve the quality of treatment before discharge.

Good business practice

As is also increasingly recognized, efficiency of resource use and responsibility in waste management are good for business. Many companies have adopted effective environmental policies to ensure that they are perceived as good corporate citizens. Many have implemented environmental management programmes to meet the requirements of voluntary regulatory systems such as ISO 14001. More fundamentally, companies are learning that it makes good business sense to minimize resource use and pollution as this represents cost savings, or waste that can be minimized.

In summary, the water available for existing cities and those of the future is increasingly constrained, and the usefulness of waste water discharged by industry is limited by the presence of harmful industrial chemicals or concentrations of substances higher than those found in domestic effluent. Under such circumstances, industry should have an interest in achieving water use efficiency, and regulators should have an interest in creating effective incentives and penalties to encourage substitution to more efficient and less polluting ways of producing goods and services. But what approaches should be taken?

Industries in their catchment contexts

Before examining some of the options available, an important point should be made about the need to consider industries in their catchment or watershed contexts. Industrial facilities and the societies they support do not exist in isolation. In discussing water management, it is useful to consider facilities and societies as part of the watersheds or catchments where they are situated. Inputs to these naturally defined areas come from groundwater extracted within the watershed, surface waters flowing or impounded within them, water imported through pipeline networks, and precipitation. Outputs occur in the form of surface water runoff, groundwater flow (to an area outside the surface watershed or to a river running from that watershed), evapotranspiration, and artificial waste water or storm water discharges (e.g. through an ocean outfall). The interrelationships between all these elements must be borne in mind.

Uncontrolled ocean discharge

Urban systems are designed and built to supply residents and industry only. Generally there is no recognition of the link between these systems and,

Table 1
How much water is used for the production of...?

Product	Water consumed (litres)
4 automobile tyres	760,000
Metal for 1 car	450,000
1 kg of cotton	10,000
1 kg of sugar	8000
1 kg of rice	4500
1 kg of butter	4000
1 kg of wheat	1500
1 egg	1000
1 loaf of bread (800 grams)	220
1 litre of milk	140
1 kg of strawberries	140
1 kg of cucumbers	15
1 litre of beer	12-16
1 newspaper	9

Source: Environment Canada

Table 2
Cascading uses of paper

Value of use	Product
1st	Writing paper, graphics
2nd	Fibre input to newspapers
3rd	Packaging (high-grade)
4th	Packaging (low-grade)
5th	Toilet paper, single use products

for example, agriculture within a catchment, or environmental n
Yet each relies on water resource the watershed. A more integrated sophisticated approach will be n sary, and industry has a part to pl this regard.

Options: creating financia incentives

Looking at some of the options a able in this context, attention nat ly focuses first on water conserva Since temporal and spatial variab in supplies means water must be sidered a scarce resource in many tions (particularly those where most ur development will occur in the next 30 to years), water will need to be rationed in order shared among all users and ecosystems. Ma forces are the best means of achieving effecti not always equitable, distribution of a fi resource.

Water would be a controllable cost for indu if pricing were introduced that

- accurately reflected scarcity and the cost of w supply and waste water treatment;
- incorporated such environmental external as the loss of ecosystem function;
- was linked to the volume consumed.

Even where a price is charged, in many ju dictions it often takes the form of a tax, which p vides no incentive to industry to improve per mance as taxes often cannot be avoided. accurate price would give industry an incentiv keep reducing water use as long as it was econo ical to do so.

While governments can of course ration wa this reduces the incentive for industry to be fl ble in its investment decisions. For example, co plex feedback mechanisms would be required make government decision makers aware opportunities for industry to become more e cient. Furthermore, industry has no real incent to improve efficiency where there is no financ gain. If government decreed, say, a 10% reducti of industrial water consumption, a compa could be expected to take only such steps as w necessary to achieve this goal, and it would be d ficult for policy makers to know whether mo could be achieved. But if water were a controlla cost for industry, and there were a continu incentive for improvement, work to achieve t initial 10% reduction might reveal opportuniti for process reformulation that would reduce wa use even further – *and it would be carried o because there was a financial incentive to do so.* long as the payback period is reasonable, ongoi improvement can logically be expected.

Of course, significant reforms are required many jurisdictions to ensure that prices are acc rately structured. And this argument does not ta equity into account. Water is vital for human li No user should be deprived for economic reaso of the water he or she needs as a minimum. How ever, social policies to achieve equitable ends c operate side-by-side with effective pricing strategi

It is often claimed that conflict exists between the profit motive of water companies (particularly private ones) and water conservation. This may be so, but before drawing any conclusions one needs to understand cost flows within a catchment and among all water systems. The cost of demand management initiatives (programmes designed to reduce water use by consumers, which may include but are not necessarily limited to scarcity-based pricing) should consider not only the revenue lost by water companies but also the water saved (and not paid for) by consumers. Say a water company runs an education campaign concerned with industrial water use in order to encourage frugality. The utility will lose marginal revenue, but consumers will defer the full unit cost of water purchases. Every sale lost by a utility could reduce the total profit generated by US$ 0.30/kilolitre. Consumers may save US$ 1.00/kilolitre, however, a net societal gain of US$ 0.70. When this amount is added to savings generated upstream as future infrastructure requirements are deferred, the "cost" of demand management may in fact be a benefit economically.

Equally, a pricing strategy that reduces consumption by making water a controllable cost will not necessarily lead to reduced profit for the supplier, assuming an adequate rate of return is included in the price charged. Note, too, that having to rely on sales rather than tax revenue also provides incentives for water suppliers to become more efficient as a means of increasing their return on investment; all increases in revenue are not generated by sales.

Nor do all financial incentives need to take the form of a direct price charged per unit of water (though this is likely to be critical to the success of any industrial water use policy). Innovative programmes include those that entail water trading and incentive/disincentive systems.

Trading systems might typically involve a cap on allowable water use among a group of companies or in a geographical area, or even for a water retailer. Each trading entity would be allowed a limited number of trading licences. If it were able to improve its water use efficiency, these licences could be sold to another trader not able to operate within the limits of its licences. Here, while government creates a market through regulation, that market obviates the need for feedback loops to policy makers (except for monitoring compliance).

Where it is necessary to decrease water use over a period of time to levels below that allowed under the initial allocation of licences, available licences could be reduced annually or the regulator could acquire, say, 5% of the water rights available upon each trade. Speculation, where trading operates within a stock market style arrangement, can reduce available licences further and push up the price, though government may need to step in to avert short-term adverse economic impacts on industry. A company that introduces a more innovative supply concept, such as recycling and storm water harvesting, stands to benefit significantly if there is a tight market for water licences.

Natural catchment delineated (Freshwater Beach, New South Wales, Australia)

Incentive and disincentive systems also harness market forces, at least to a certain extent. Under these arrangements there is a step increase in tariffs above a set point, or a payment is made related to the degree to which a company reduces its water consumption below a set target.

Examples of trading and incentive and disincentive programmes exist for natural resources, including water, around the world. However, use of these programmes is not as widespread as their success indicates that it should be.

Market forces may also be exploited in the case of waste water. Regulators can introduce financial incentives to reduce releases from industrial premises. Some chemicals, such as mercury, must simply be banned. In the case of less environmentally persistent or acutely toxic substances (and where prohibition within a very short time period would be prohibitively costly), incentive-based charges reflecting the concentration and volume of the substance discharged can be used.

To boost the incentive to reduce very large or very concentrated amounts of a substance, charges can be increased exponentially with volume and concentration. They can be increased over time to provide an ongoing incentive, though it is important that they be announced well in advance and reflect environmental need, rather than being disguised revenue raising (taxation). Again, effective systems such as this are in place around the world. In various examples, the quality of the sludge produced at sewage treatment plants where such programmes are actively pursued has increased to such an extent that what was previously considered toxic or restricted waste is now a usable by-product.

The above approaches must be implemented in a manner that does not inhibit companies' productive capacity or long-term profitability, but this is certainly achievable. Indeed, there may be significant benefits to the companies concerned. Less water use, for example, reduces pumping, heating and cooling costs. Some companies have found it beneficial to install their own treatment plants and so produce water for their industrial processes. Such measures can result in significant savings, reducing the payback time for new equipment to a few years or less.

Government-industry-partnerships and environmental standards

Pricing and regulation can create sound incentives for industry to improve performance. Very impressive improvements are also achievable through partnerships between industry and government (as well as communities in the industry's catchment) and through adoption of ethical or sound environmental policies by industry. An advantage of such approaches is that they require dialogue between regulators and the regulated, meaning that companies' particular circumstances can be taken into account.

For example, pricing policies are likely to affect all companies simultaneously. However, some of them, particularly SMEs, may not have the capacity to absorb costs or to invest in pollution control or efficiency technologies even if savings might be generated in the long run.

In a partnership enterprises may negotiate, say, a timetable for process improvement or achievement of a goal. Such agreements need to be reported on and audited to assure compliance. They may contain incentives or penalties for non-compliance. The advantage of agreements is that they can be more responsive to industry needs than pricing, and can therefore be more directly attuned to national industrial development policies than would a uniform price arrangement. To reduce the administrative burden and the complexity of feedback mechanisms, agreements can be negotiated for a class of enterprise (particularly valuable with regard to SMEs). National environmental protection policies in many countries provide examples of blanket agreements with industry.

In the case of adoption by industry of voluntary ethical/environmental standards, it is industry that takes the initiative. Standards such as ISO 14001 for environmental management set goals and prescribe processes for achieving particular outcomes. Companies may also adopt their own principle-centred approaches, which can include some very far-reaching and challenging targets such as zero emissions or closed-loop manufacturing.

Cleaner production

Many companies are now adopting the principle of cleaner production, with the most ethical and environmentally committed companies working towards zero emissions. 3M has adopted a pollution prevention strategy that it calls 3P (for Pollution Prevention Pays). This strategy is "based on the reality that pollution prevention is more environmentally effective, technically sound and economical than conventional pollution control equipment."[1] The Sumitomo Bakelite Group says its environmental philosophy has led it to achieve zero emissions at more than ten of its plants.[2]

Companies embarking on a cleaner production strategy essentially work back along a continuum from end-of-pipe to systemic methods to reduce resource use and emissions, which requires a fundamental rethink of production processes. For

some companies, the simplest and most cost-effective steps involve activities such as patching leaks in pipes and sweeping (rather than using hoses) to wash away dirt. These "no regrets," "good housekeeping" options really just boil down to good management.

More fundamentally, companies can entirely rethink production processes. Womack and Jones[3] (1997) refer to the term "*muda*" as used by the head of Toyota Motor Company, Taiichi Ohno. His philosophy was that anything that did not directly contribute to the production of a product and was left over after the production process (including time and storage of inventory) was *muda* and therefore waste – which was always to be avoided. This philosophy extended up and down the production chain. Companies pursuing Ohno's strategy look at the inputs to their production processes to determine if there is a "leaner" way of achieving the same ends. This approach, while not directly related to pollution prevention and responsible resource use (it was developed more as a means of improving business success), has immediate parallels to these goals.

The concept has also been extended to the examination of water, energy and other natural resources "embodied" in raw material inputs. Analytical techniques might show, for example, that it is more energy intensive and polluting to use a raw material dried with coal-fired energy than with solar power.

In a true cleaner production approach, the product supplied to the consumer is later recovered for reuse. Producing an aluminium can from a recycled source is significantly less water and energy intensive than producing it from raw materials. That is a simple example; often recovery and reuse requires product reformulation. Designs that facilitate dismantling and that use a minimum number of separate materials (e.g. all HDPE plastic, rather than HDPE and PVC in the same unit) are work towards this end.

Examples of water use

Table 1 should be considered in the light of the discussion of cleaner production above. Two examples of water use are worth particular comment:

1. *Rice:* As a crop, rice is water intensive. While it is of vital importance as a staple food, its monetary value is quite low. Rice grows well in wet areas where flood irrigation is easily accomplished. In dry areas it is probably not economical to grow rice unless the cost of water is artificially low (ignoring scarcity value). Diversion of water from rivers for rice cultivation may damage the environment. More effective pricing, transition strategies, and, potentially, a trading programme might lead to a shift in production from low-value to high-value crops.
2. *Paper:* Driven by concerns about the impact of toxic waste discharges and total water use, paper producers have made production processes less toxic (moving from chlorine bleach to other processes, such as oxygen) and in doing so have significantly reduced water consumption through recycling and better material management. It now takes half as much water to produce a unit of paper as it did 20 years ago. Paper manufacturers have also found "cascading" uses for their products, as shown in Table 2.

Integrating industrial and urban water use

Opportunities exist to integrate industry within the urban environment and natural ecosystems. Urban environments have been greatly modified. Often virtually no natural ecosystems still function unless they have adapted to urban conditions. Rather than perceiving industries as existing only in their own right, their relationship to their catchments could be considered in their operation and planning (for new or existing facilities). An industry that requires water for its processes could, for example, further treat effluent by discharging the flow through artificial wetlands, replacing wetlands previously destroyed through urbanization. Treated waste water could be reinjected into aquifers to prevent their depletion or saltwater intrusion, and could potentially be reused downstream. Rainwater gathered from the roofs of large industrial buildings could be used to irrigate playing fields or local market gardens.

Similarly, treated waste water from households – no longer suitable for drinking, but nevertheless of high quality – could form an input to industrial processes. Looking widely at the catchment, such "cascading" uses of water would obviate the need for a new water source for a growing city and would avoid other infrastructure costs. The process best describing this approach is "industrial ecology" – looking at the functioning of a unit (the industrial facility) within the "ecosystem" (the urban area) that supports us, other life, and other systems and processes. Techniques for industrial ecology analysis, or the analysis of "urban metabolism," are emerging strongly at the moment.

Agriculture and "virtual water"

Water use in agriculture is intensive. An emerging global issue is the shift in trade in agricultural (including forestry) products to developing countries. In addition, water is frequently subsidized or at least underpriced in economies in transition, reflecting the need to generate foreign exchange earnings. When agricultural products are exported from developing countries, they represent trade in virtual water – that is, the water "embodied" in the products themselves. Trade in "virtual water" frequently represents exports of water from dry to wet countries. It is a largely unexamined effect of globalization that demands attention.

Water use by livestock (typical developed country estimates)

Livestock	litres per head per day
Milk cows	154
Steers	51
Bulls	97
Calves	25
Other cattle	64
Horses	68
Pigs	9
Sheep	3
Hens and chickens	0.3
Other poultry	0.5

Source: Environment Canada

Notes

1. See www.3m.com/about3m/sustainability/policies_ehs_tradition.jhtml.
2. See www.sumibe.co.jp/english/kankyou/pdf/rc2002_E01.pdf.
3. See list of references below.

References

Womack, James P. and Daniel T. Jones (1997) *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon and Schuster.

Lens, Piet, Look Hulshoff Pol, Peter Wilderer and Takashi Asano (eds.) (2002) *Water Recycling and Resource Recovery by Industry: Analysis, Technologies and Implementation*, IWA (International Water Association) Publishing.

Hawken, Paul, Amory B. Lovins and L. Hunter Lovins (1999) *Natural Capitalism: The Next Industrial Revolution*, Earthscan. ◆

Water policies in the 21st century

Asit K. Biswas, President, Third World Centre for Water Management, Avenida Manantial Oriente No. 27, Los Clubes, Atizapan, Estado de Mexico, 52958 Mexico (akbiswas@att.net.mx)

Summary

Water policy has generally been treated as an important issue. However, rational formulation and implementation of water policies have often been given only lip service. 21st century water policies must take into account changes that have occurred in the last decade (e.g. the trend towards decentralization, expanded roles for the private sector and NGOs) as well as the very great changes that are likely to occur. Future water policies will need to address diverse social interests and agendas, rapid changes in technology, globalization, relentless economic competition, lack of political certainty, and steadily increasing human aspirations.

Résumé

Bien que la politique de l'eau soit généralement considérée comme une question importante, la formulation rationnelle des politiques de l'eau et leur mise en œuvre sont souvent restées un vœu pieux. Les politiques de l'eau du XXIe siècle doivent prendre en compte les changements intervenus ces dix dernières années (par exemple, la tendance à la décentralisation, les nouveaux rôles dévolus au secteur privé et aux ONG), ainsi que les bouleversements auxquels on peut encore s'attendre. Les politiques de l'eau futures devront tenir compte de divers intérêts et programmes sociaux, de l'évolution rapide des technologies, de la mondialisation, de la compétition impitoyable entre les acteurs économiques, du manque de certitude politique et des aspirations sans cesse croissantes des hommes.

Resumen

En términos generales, siempre se ha dado importancia al tema de la política sobre aguas. Sin embargo, es muy común que la formulación y la ejecución racional de dichas políticas se mantengan en el ámbito de las promesas incumplidas. En el siglo XXI, las políticas sobre aguas deben tomar en cuenta los cambios registrados en los últimos diez años (por ejemplo, la tendencia a la descentralización, la mayor participación del sector privado y de las ONG), además de los grandes cambios que tienen grandes probabilidades de ocurrir. Las nuevas políticas sobre aguas deberán atender los diversos intereses y prioridades sociales, los cambios tecnológicos, la globalización, la competencia económica implacable, la falta de certidumbre política y las crecientes aspiraciones humanas.

A vast change is taking place in the world's water policy and management landscape, the extent and magnitude of which neither the water nor development professions has ever witnessed. An objective, comprehensive review of the latest and foreseeable trends indicates that the world of water management will change more during the next 20 years than it did in the previous 2000. Many of the important drivers of this change will come from outside the water sector and, unlike recent and past experience, the water profession will have limited or no control over them. Hence, water professionals will have to react to these changes very quickly.

Among the drivers of change are globalization, technological developments, the communications and information revolution, and the changing nature of water problems and their solutions in different parts of the world. Implications of some of these can be foreseen, though they are basically being ignored now. In other cases, such as the communications and information revolution, it is very difficult to know, on the basis of existing knowledge and experience, how some of these developments will affect the water sector. But all these new and emerging factors will radically alter water use, availability and management practices.

Water policy formulation

A critical review of water management policies, strategies and plans indicates that these existing approaches are still too traditional, conservative, unisectoral and engineering-oriented; are overly focused on water quantity; are too hierarchical, top-down and politically correct; place too much emphasis on the past; give too little consideration to future trends and emerging developments; and are not yet adequately integrated with energy, health and industrial policies.

Because of several fundamental changes that have already occurred in the water sector and related sectors, and the further changes that can be expected, water policies of the 21st century need to be significantly different from those of the 20th century. Tomorrow's water problems can no longer be solved with yesterday's knowledge base and the day before yesterday's policies.

Let us consider one issue that has already radically changed the water policy-making landscape within a very short period, only a decade or so. Historically, water management has fallen within the purview of the public sector. Ministries, usually at central government level, used to formulate water policies unilaterally in one form or another for a period of five to ten years, without any consultation with the beneficiaries and/or stakeholders, or much discussion with state- or municipal-level institutions. Up until around 1990 the private sector and non-governmental organizations had virtually no discernible role to play in policy formulation (a state of affairs, it should be noted, that prevailed not only for the water sector but also for other developmental sectors).

The central water ministry generally set targets, and then resources were requested from the finance ministry. The water ministry was responsible for achieving the targets it had itself established, using the funds that were released to it by the finance ministry. Again, water users, the private sector and NGOs had no significant role. If a country wished to borrow funds from the World Bank, a regional development bank or bilateral aid agencies to build, operate and/or rehabilitate water systems, it naturally had to comply with the policies and requirements of the lenders/donors concerned. The overall process was thus comparatively simple and straightforward.

In recent years this process has been changing radically. The central institutions have steadily lost power, resources, authority and reputation, for a variety of reasons. The trends towards decentralization have often meant that states or provinces have become increasingly powerful and assertive, even though sometimes central institutions do their best to block the flow of resources and expertise to the subnational levels in a variety of subtle and not-so-subtle ways. And the private sector is increasingly becoming an important player in water-related activities, while national NGOs in many countries have become vocal, active and media-savvy, hence often carving out roles for themselves in water policy formulation and implementation. International NGOs, which had little if any role in the process until 1990 or so, have become another important player, especially for countries seeking foreign capital and expertise through all major external channels of support. In recent years international NGOs have had perceptible effects, for example on the international funding arrangements for the Three Gorges Dam in China, the Sardar Sarovar Dam in India, the Arun III Dam in Nepal and the Ilisu Dam in Turkey.

These developments should be welcomed for a variety of reasons, since they are essential for the strengthening of democratic processes. Water policy formulation during the past decade has

become more consultative, participatory and transparent than at any other time in history. The analyses and processes involved are receiving serious and extensive external scrutiny; as a result, they are becoming more reliable, comprehensive and realistic. These are unquestionably positive developments in terms of the overall welfare of society.

The rapid changes, however, have entailed their share of problems and difficulties as well. The various players in the public and private sectors and NGOs have their own agendas and vested interests. They do they not necessarily have common goals and objectives. Even within public sector institutions (central, state, municipal) there are often differing objectives and approaches. The views of the water and environment ministries may diverge on several issues and projects. When policies on international rivers are to be formulated, the foreign ministry generally comes to the fore even though its officials may have very limited experience and expertise in water matters. And water may not necessarily be the most important issue in their view, despite the fact that the focus of discussion is international water bodies. In several current cases of negotiations on major international rivers, where the author is advising governments, the views and approaches of the foreign ministries are sometimes diametrically opposed to those of the water ministries.

Similarly, private sector entities and NGOs often have different objectives and views. Conflict resolution within a given group – say, public sector institutions or NGOs – is invariably complex and sometimes nearly impossible.

Another issue is public participation. While it is generally agreed that this is both essential and desirable, current techniques and methodologies are simply incapable of ensuring that the public at large participates meaningfully in water policy formulation and implementation. In the vast majority of cases, the general public has hardly any interest in water policies and its members are often conspicuous by their absence from those forums open to them. The individuals or NGOs claiming to speak for the public generally have no real mandate to do so. Thus "public participation" has often been reduced to consultations with the most vocal and articulate individuals and NGOs, with nothing to keep them from attempting to manipulate the process to serve their own interests and beliefs.

There is also a fundamental question that the water development profession has never addressed in any meaningful fashion: which public is to be consulted. For example, does the public mean only the people from the project area concerned, or should it also include people from outside the country and the project area, as often appears to be the case at present?

Take the Sardar Sarovar project in India. The people from the state of Gujarat, where most beneficiaries of the project live, overwhelmingly favour it, as do most local NGOs. Narmada Bachao Andolan, the main opposing NGO, claims to represent the people to be resettled from the Sardar Sarovar project area. But there has never been even a single representative of these people holding a policy-making position within the NGO during its nearly two decades of existence. One could legitimately ask: how democratic is such a state of affairs? And how appropriate is it for the views of the people living outside the project area – say, in Delhi or Mumbai, or even in Washington, DC, California or Tokyo – to influence developments in a project area whose inhabitants back a given policy?

Answers are urgently needed to these difficult questions. Regrettably, discussions on such issues have hardly even begun within the water profession. (This should not be taken as an endorsement of the Sardar Sarovar Dam; objective analyses of its benefits and costs and nature of the beneficiaries have yet to be carried out.)

More generally, the problem that needs to be addressed is how to formulate future water policies in consultation with multiple stakeholders having multiple interests, conflicting views and differing priorities. Though this is not primarily a technical or economic issue, a definitive answer would help with devising a process for formulating rational water policies in the future. Urgent research needs to be carried out in this overall area, especially by social scientists, so that appropriate water policies can be formulated, implemented and updated in coming years in a timely and cost-effective manner.

Once a policy is formulated and agreed, the next question is how to ensure that all stakeholders play their respective roles so that the policy can be effectively implemented. With the multitude of stakeholders involved, how can their activities be coordinated so as to reach the shared goals of the agreed policy? Who should be entrusted to coordinate the activities, and where will the funds to carry out the activities come from? What type of sanctions can be considered if a given stakeholder does not carry out activities promptly and as agreed? Answers to these questions must also be found in the next few years.

Some policy implications for the future

Many likely developments in the 21st century will, as we have noted, make water policies very different from those formulated earlier. Some of these developments can be foreseen in general terms, though their timing and their impact on water management practices are impossible to predict. The following are likely to be among the new developments:

- The global population will probably stabilize after 2050. This would bring some advantages, as well as certain disadvantages, for the water sector. World population may stabilize at less than current consensus estimates, and the populations of many countries will likely stabilize well before the world population does. There is no precedent in modern history to indicate how global population stabilization might affect the water sector.
- The water profession is now primarily concerned with urbanization trends and how water and waste water services can be provided to an increasing number of megacities. But, as these huge cities are politically and financially powerful, they will probably muddle through; the more difficult problem in the future is likely to be with medium-sized cities, those with, say, a population of 500,000 to 1,000,000. These cities may not have the political, economic and institutional power to ensure that their water and waste water management requirements are met.
- While urbanization in the developing world is very visible, concurrently a ruralization trend can be observed in many countries, from Mexico to Morocco. The number of hamlets of 2500 or fewer people has been increasing exponentially in many developing countries over the past two decades. We do not yet know who the people forming these communities are, where they migrated from, or why they are moving to areas devoid of essential services. All that can be said at present is that this process in the developing world involves almost exclusively the poor and marginalized, who have no political voice or economic power. Thus, not surprisingly, neither water professionals nor policy makers are even aware of the situation, never mind looking for policy measures to deal with the daunting task of providing water and sanitation services to these dispersed hamlets.
- The current emphasis is on technical and economic issues, but the water problems of the future are likely to have greater social, environmental and political components. These aspects can be somewhat amorphous. They are not easy to deal with because they are often based on perceptions which may or may not be correct. Technical and economic issues are concerned with facts, which can be analyzed using standard, universally acceptable techniques, leading to results that are likely to be similar irrespective of who carries out the analyses (assuming they are properly done). But consideration of social, environmental and political issues invariably entails value judgements, which differ depending upon the analysts and the stakeholders concerned. Thus an important component of future water policy has to be provision of information to, and communication with, the various stakeholders. As the 21st century progresses, information and communication are likely to become more and more critical, whereas in the past they were largely considered only as afterthoughts.
- The private sector and water pricing are likely to be increasingly important aspects of water policy, probably contributing to significant advances in demand management at municipal level. As a result, within a mere decade or so household and industrial water requirements may be revised downwards significantly.
- Globalization, the communications and information revolution, and related developments will grow more and more important for water management. They are already collapsing borders and barriers between countries and between development-related sectors and disciplines. For example, the water requirements of the Mexico-United States border region have skyrocketed during the past five years. Under the North American Free Trade Agreement (NAFTA), exports of manufactured products from Mexico to Canada and the

US have rapidly accelerated, with industrialization and job growth that have involved major migrations from different parts of Mexico to the border area. Hence the growth in water requirements in the border region, to meet both household and industrial needs. Water demand in major border cities such as Ciudad Juarez has increased by over 15% per year in the past five years. Water quality has generally deteriorated because waste water treatment has not kept up. Consequently, incidences of waterborne diseases in the border towns are significantly higher than the Mexican national averages.

Globalization will have an increasing impact on water management practices and processes. It needs to be considered explicitly in any new water policy formulation framework. For example, free trade in agricultural products under NAFTA, along with reductions in US agricultural subsidies, would result in major changes in water use and availability in Canada, the US and Mexico. No government or academic institution has even started to explore the likely effects of this. Similarly, as more and more Japanese small farmers abandon rice farming due to economic pressures and progressive opening of the rice market in Japan, paddy farms, which now provide floodwater storage, will disappear. While paddy fields are small individually, collectively they store large amounts of water. Release of this water will necessitate significant, costly adjustments to the sophisticated flood control system of Japan's Kanto Plain. Globalization will affect water management in most countries, for various reasons and in numerous ways, within the next two decades. Yet national governments and international institutions have thus far ignored the issue.

♦ Past water policies have generally assumed, erroneously, that technology would basically remain stationary. Current trends indicate, however, that technological developments will radically change water requirements and management practices. Many of these developments will take place outside the water sector but may have profound impacts on it. Moreover, technology has always had significant impacts on water. For example, in 1961 Asia's average cereal yield was 930 kg/ha. By 1997, with significant improvements in technology and management practices, the harvest had increased so much that, had the same yield ratio continued, nearly 600 million hectares of additional land of the same quality would have had to be cultivated to produce the same quantity. Farming accounts for over 80% of total water requirements in much of Asia. Without technological advances, Asia's water use patterns would have been very different in the past four decades. It is now clear that advances in areas like biotechnology and desalination will have to have major implications for water policy formulation in the future if realistic policies are to be developed.

♦ Water quality management must become a major component of any new water policy. Water quality problems are now serious in all developing countries. Nearly all surface water bodies in and near urban-industrial centres are already highly contaminated. Recent estimates by the Third World Centre for Water Management (www.thirdworldcentre.org) indicate that, contrary to official rhetoric and estimates by international organizations, only about 6% of waste water generated in Latin America is properly treated and disposed of. The situation is unlikely to be much different for Asia and Africa. Furthermore, no reasonable estimates exist as to the investment needed for Latin America to increase waste water treatment to a more acceptable 60-70%. The costs are likely to be astronomical, at a level that most developing countries would find it extremely difficult to meet. In addition, rapid capacity building for proper water quality management is likely to be a Herculean task.

Conclusions

The world is changing rapidly. We must undertake objective, reliable analysis of the potential prospects for and constraints on future water systems in the light of this change. Water policies of the future will have to address rapidly diversifying interests and agendas, conflicting views, rapid technological changes, globalization, relentless economic competition, political uncertainties and people's higher aspirations. Theoretical and conceptual approaches, irrespective of how attractive they may be, will not be much use unless they can be made operational. This will not be easy, but it is a task the water profession must face squarely and promptly. The profession has only two choices: to continue as before with a business-as-usual policy that is unlikely to contribute significantly to poverty alleviation and equitable development; or to continue in earnest to develop new policies that could improve people's quality of life and satisfy their aspirations and expectations.

It is now evident that the major issues facing the world are interrelated. The dynamics of the future of mankind will be determined not by any single individual issue, but by the results of the interactions of a multitude of issues. As the global population continues to grow in the short term, more food, energy and other resources will be required, which in turn means rational water policies will be a must. Practical solutions to the most pressing human problems, including water problems, will entail greater investment, more technology, higher human capacities, and intensified cooperation among countries, sectors and social strata. The relationships involved are often global in character, and hence can best be understood within a global context and resolved within a global framework (though relying on a wide variety of integrated national and regional responses). Water policies must also be formulated within this overall framework.

It will not be easy to formulate the new water policies that could lead to rational water management. There will be successes and failures, and the water profession will have to travel many as yet untrodden paths. We will undoubtedly find some shortcuts but also run into obstacles and bumps – as is to be expected in new, uncharted territory.

References

Biswas, Asit K. (2001) Water Policies in the Developing World, in *International Journal of Water Resources Development*, Vol. 17, No. 4, pp. 489-499.

Biswas, Asit K. and C. Tortajada (2004) *Appraising the Concept of Sustainable Development: Water Management and Related Environmental Challenges*, Oxford University Press.

Biswas, Asit K. and C. Tortajada (2004) *Water and Regional Development*, Oxford University Press.

Faruqui, N.I., A.K. Biswas and M.J. Bino (eds.) (2001) *Water Management in Islam*, United Nations University Press, Tokyo.

Tortajada, C., B.P.F. Braga, A.K. Biswas and L. Garcia (2003) *Water Policies and Institutions in Latin America*, Oxford University Press.

Uitto, J.I. and A.K. Biswas (eds.) (2000) *Water for Urban Areas: Challenges and Perspectives*, United Nations University Press, Tokyo.

♦

Act locally! How to involve small-scale enterprises in providing water supply to rural areas

François Brikké, Senior Consultant, IRC, International Water and Sanitation Centre
PO Box 2869, 2601 CW Delft, The Netherlands (brikke@wanadoo.fr)

Involving the private sector in the management of urban water supply is often considered one of the options for improving service efficiency in developing countries. But what about the management of rural water supply? Is it the same? How can small-scale enterprises best be involved? The purpose of this article is to show how small-scale enterprise can be involved in water supply provision in rural areas, taking the example of a study made in Morocco.

Water supply in rural areas of Morocco has developed much more slowly than in urban areas. Coverage in rural areas in 2000 was estimated at 40%. The water supply sector is largely dominated by ONEP (Office National de l'Eau Potable, or the National Office for Drinking Water), which is now in charge of promoting the generalization of access to water supply in the country.[1] ONEP faces two challenges: increasing water supply coverage, and ensuring that the water supply systems put in place are sustainable. To meet these challenges, it has been struggling to find effective management systems for water supply systems in rural areas.

Involvement of small-scale enterprises was one of the options considered. An initial pilot study on management options was carried out in the Moroccan province of Zougha Moulay Yacoub in 2001, with technical support from the UN Food and Agriculture Organization (FAO). This study served as a basis for replication and learning by experience in other provinces.

Initial assumptions

The study team considered the following assumptions:

- The National Rural Development Policy is conducive to institutional changes and to involvement of the private sector.
- ONEP wishes to decentralize, delegate and sub-contract the management of water supply systems in rural areas.
- At community level, the private sector consists of local artisans and relatively small enterprises (one to five persons), which are not necessarily involved only in water related activities. In fact, for several years ONEP has had a training programme in plumbing, electricity and caretaking[2] for

Table 1
Present and potential future roles of stakeholders involved in rural water supply (ONEP projects)

Rural water supply activities	ONEP		Local authorities		Medium-sized enterprises		Small-scale enterprises		User associations		Standpipe caretaker		Population	
	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future
Implementing projects														
• Planning - programmming	P	··	S	▲	–	–	–	–	–	▲	–	–	m	▲
• Financing	P	··	S	··	–	–	–	–	–	–	–	–	S	··
Operation of pumping station														
• Operation and maintenance	P	▼	–	–	m	▲	m	▲	–	–	–	–	–	–
• Caretaking	P	▼	–	–	m	▲	S	··	–	–	–	–	–	–
Maintenance of major pipes														
• Leakage control	P	▼	–	–	m	▲	m	▲	–	–	–	–	–	–
• Repairs and maintenance	P	▼	–	–	m	▲	m	··	–	–	–	–	–	–
Maintenance of local network														
• Leakage control	P	▼	–	–	m	▲	m	▲	–	▲	–	–	–	–
• Standpipe maintenance	–	–	–	–	–	–	m	▲	–	▲	P	··	–	–
• Household connections	P	▼	–	–	–	–	m	▲	–	▲	–	–	–	▲
Commercial management														
• Consumer administration	P	▼	–	–	–	–	–	–	–	▲	–	–	–	–
• Water meter reading	P	▼	–	–	–	▲	–	▲	–	▲	–	–	–	–
• Billing and collection	P	▼	–	–	–	–	–	–	–	–	S	··	–	–
"Social" management														
• Control of non-payments	m	▼	m	▲	–	–	–	–	–	▲	S	··	–	▲
• Social mobilization	m	··	m	▲	–	–	–	–	–	▲	–	–	–	–
Monitoring and backstopping														
• Control on norms	P	··	–	–	–	–	–	–	–	–	–	–	–	–
• Water quality surveillance	P	··	–	–	m	▲	m	▲	–	▲	–	▲	–	▲
• Training and sensitization	P	··	–	–	–	–	–	–	–	–	–	–	–	–
• Monitoring	P	··	–	▲	–	–	–	–	–	–	–	–	–	–

Legend: P: Primary role; S: Significant role; m: Moderate role; –: None or insignificant; ·· : No major change; ▲ Increase; ▼ Decrease

small-scale entrepreneurs, to whom it has offered contracts of one to two years once training was completed.

- There is better availability of adequate expertise in villages close to urban areas than in remote areas.

What role for small-scale enterprises?

The private sector is only one of the actors involved in supplying water to rural areas. It is therefore important to map out the capacity of the various stakeholders at local level, and to understand how they interact. **Table 1** provides an overview of the present and potential future roles of various stakeholders, given present trends and sector strategies. This exercise has been tremendously helpful. It has helped situate small-scale enterprises in a context and show what their contributions could be.

Analysis revealed that small-scale enterprises (private entrepreneurs, as well as small firms with two to five persons) could be involved in the following activities:

- pumping station operation, maintenance and caretaking;
- leakage control, repairs, and maintenance of major pipes;
- leakage control, repairs and maintenance of local piped network, standpipes and household connexions;
- water meter reading;
- water quality surveillance.

Local institutional diagnosis

The study team also carried out an institutional diagnosis at local level to assess each stakeholder's capacity to be involved in the operation, maintenance and management of water supply (**Table 2**). The criteria were as follows:

- technical capacity (human resources, equipment, tools and experience);
- commercial management capacity (consumer administration, billing, collection);
- social management capacity (communication with communities);
- willingness to be involved (operators' interest in being involved in maintenance or management activities, given costs and complexity as well as the perspective of profits);
- acceptance by communities (populations have a history and experience with various operators).
- ease of implementation (some operators could be involved only at great cost);
- interest for ONEP (the agency could have strategic preferences).

This inventory of capacities has helped with the design of the best institutional set-up for managing water supplies in rural areas, as well as with defining necessary accompanying measures. All the information was collected through visiting a sample of operators and inviting representatives of small-scale enterprises to take part in round table discussions and information exchange.

Lessons learned about small-scale enterprises

Small-scale enterprises have some technical experience and equipment, but they lack experience with commercial management. Moreover, despite their great willingness to be involved, there is a certain resistance in communities, especially if small-scale enterprises are unknown to them. Communities clearly prefer local artisans that are known to them.

It should be mentioned that small-scale enterprises are mostly willing to intervene in the context of service contracts but not management contracts. Service contracts are those between an operator (in this case, a small-scale enterprise) and ONEP that deal with specific activities at an agreed rate, including performance related remuneration. This type of contract has the advantage of offering the operator a "safe" income, as it does not rely on levels of water consumption or the price of water. Management contracts, however, delegate management of a water supply system to an operator. The operator would earn its income on the basis of selling water. Small-scale operators interviewed did not have confidence in management contracts, as they were unsure about the income they would be able to generate.

Table 2
Institutional diagnosis of operators in the province of Moulay Yacoub

	Medium sized enterprise	Small-scale enterprise	Local artisans	Local authorities	Standpipe caretaker	Communities
Technical capacity	3	2	1	1	0	0
Commercial management capacity	1	1	0	1	1	1
Social management capacity	1	2	2	2	2	3
Willingness to be involved	2	3	0	1	3	1
Acceptance by communities	0	1	3	1	3	3
Ease of implementation	3	2	1	1	3	1
Interest for ONEP	3	3	1	1	2	2

0 = none or insignificant 1 = low 2 = medium 3 = high

The Directorate General for Hydraulics (DGH) was still implementing a rural water supply project during the study, mainly using the model of community-managed water supply (in which user associations are fully in charge of operation, maintenance and management, including tariff setting). Experience shows that technical expertise exists in rural areas, but that in many cases tariff setting, financial management and monitoring of water quality have not been satisfactory. The study also demonstrated that agricultural cooperatives had the capacity to fully manage a water supply system, and that they had had a strong financial management capacity. This management model has been recommended wherever there are cooperatives.

Contractual arrangements established by ONEP

Today ONEP is clearly promoting the involvement of small and medium-sized enterprises in the operation and maintenance of rural water supply systems. This will be done using service contracts until there is more proven capacity to take over management roles. ONEP will therefore be sub-contracting operators. It will continue to have overall responsibility and to make decisions on tariff-setting, under authority delegated to it by local authorities. This situation could nevertheless change rapidly, especially in the case of remote water supply systems where all activities will have to be delegated to a user association or a small-scale enterprise.

Notes

1. The DGH (Directorate General for Hydraulic) formerly shared this mandate.
2. Responsibility for pumping station operations, general cleanliness of station areas, and pipe/valve maintenance.

Recommended reading

Collignon, B., and M. Vezina (2000) *Independent water and sanitation providers in African Cities*, World Bank.

Solo, T.M. (2003) *Independent water entrepreneurs in Latin America: the*

Meeting targets for water supply and sanitation: the African challenge

Shehu Yahaya, Operations Policy and Review Department, African Development Bank, BP 323, 1002 Tunis Belvédère, Tunisia (s.yahaya@afdb.org)

Summary

Of the world's regions, Africa suffers most from inadequate access to water supply and to sanitation. It is also the region with the least capacity to address these problems. A massive coordinated effort will be required to meet the internationally agreed targets for 2015. Access to water supply needs to be extended to 350 million additional Africans and sanitation to 363 million. This article reviews some current activities of the African Ministerial Conference on Water, the Rural Water Supply and Sanitation Initiative, the water and infrastructure programme of the New Partnership for Africa's Development, and the African Water Facility.

Résumé

De toutes les régions du monde, l'Afrique est celle qui souffre le plus du manque d'accès à l'eau potable et d'installations d'assainissement. C'est aussi celle qui est la moins bien armée pour faire face à ces problèmes. Des efforts considérables et coordonnés seront nécessaires pour atteindre les objectifs décidés au niveau international pour 2015. L'accès à l'eau doit être assuré à 350 millions d'Africains supplémentaires et des installations d'assainissement à 363 millions. L'article passe en revue quelques-unes des activités en cours de la Conférence des ministres africains sur l'eau, l'initiative pour l'adduction d'eau et l'assainissement dans les zones rurales, le programme eau et infrastructures du Nouveau partenariat pour le développement de l'Afrique et du Fonds africain pour l'eau.

Resumen

De todas las regiones del mundo, África enfrenta la peor situación en cuanto al acceso al abastecimiento de agua y los servicios sanitarios. Asimismo, es la región peor preparada para enfrentar este tipo de problemas. Habrá de realizarse un esfuerzo conjunto de gran envergadura para cumplir con los objetivos acordados en la esfera internacional cuyo plazo vence en el año 2015. Es necesario ampliar el acceso al abastecimiento de agua para llegar a 350 millones más de africanos y llevar servicios sanitarios a 363 millones de habitantes. En este artículo se reseñan algunas de las actividades llevadas a cabo por la Conferencia Ministerial Africana sobre el Agua, la Iniciativa para el Abastecimiento de Agua y Servicios Sanitarios en Zonas Rurales, el programa de agua e infraestructura de la Nueva Alianza para el Desarrollo de África y el Fondo Africano para el Agua.

The critical importance of water in poverty alleviation and socio-economic development has attracted increasing attention over the last decade. Unacceptably low levels of access to clean water and to adequate sanitation by a large proportion of humanity (1.1 billion in the case of water and 2.4 billion in the case of sanitation[1]), at a time of unprecedented affluence and technological progress, are causing greater concern than ever before. This situation is all the more tragic because water is a relatively abundant resource, and the financial and technical wherewithal with which to make it available on a sustainable basis to those who desperately need it is available.

Africa is the region that suffers most from inadequate access to water supply and sanitation. It is also the region with the least capacity to address these problems. Only some 62% of its total population has access to improved water supply (compared with 82% worldwide, 81% in Asia and 85% in Latin America) and 60% to sanitation. Of 55 countries in the world whose domestic water use is below 50 litres per capita per day, 35 are in Africa.[2] These averages conceal significant variations within and among countries. For example, in sub-Saharan Africa, roughly 80% of city dwellers have water supply and sanitation coverage, compared with around 40% in rural areas.

Many targets, goals and programmes for water supply and sanitation have been initiated in the past. However, the targets of the Millennium Development Goals (MDGs), supplemented by those set at the World Summit on Sustainable Development in Johannesburg, provide the most effective rallying point for global and African efforts. These targets are to reduce by half the proportion of people without access to safe drinking water and adequate sanitation by 2015, and to achieve full coverage for safe water and sanitation and make a significant improvement in the lives of at least 100 million slum dwellers by 2020.

To meet the MDG targets for 2015, water supply coverage needs to be extended to an additional 359 million Africans and sanitation to an additional 363 million. Meeting these targets is essential if the other MDGs (e.g. eradication of poverty and hunger, universal primary education, gender equality, reduced child mortality, combating malaria and other diseases, and environmental sustainability) are to be achieved. Enormous efforts will be required – and things will need to be done differently – for Africa to stand a chance of meeting the MDGs targets for water supply and sanitation.

This article reviews a few of the efforts currently being made in Africa to meet these MDG targets. The discussion is restricted to the African Ministerial Conference on Water (AMCOW), the Rural Water Supply and Sanitation Initiative, the water infrastructure programme of the New Partnership for Africa's Development (NEPAD) and the African Water Facility.

Among the many other efforts and initiatives by stakeholders in the African water sector are those of UN agencies, the World Bank, regional economic bodies, governments, NGOs and aid donors.

AMCOW

One of the most significant initiatives in this regard during the last few years has been the establishment of the African Ministers Council on Water in April 2001. AMCOW is made up of all the African ministers of water. Its mission is "to provide political leadership, policy direction and advocacy in the use and management of water for sustainable social and economic development and the maintenance of Africa's ecosystems."

AMCOW's most important activities so far involve its assumption of leadership with respect to the NEPAD water and infrastructure programme, the African Water Facility and the Africa-EU water and sanitation partnership. The water ministers have the political responsibility to mobilize the support of African governments and the international development community for these programmes. AMCOW is also charged with working with the executing agencies to ensure that the programmes reflect the region's development imperatives.

Another activity has been the African Partnership and Implementation Conference, held in December 2003 in Addis Ababa under AMCOW auspices. AMCOW also works to coordinate the efforts of all African countries to develop and implement their plans to achieve the Millennium Development Goals.

AMCOW is a political voice for Africa concerning the issue of water. It is a focal point around which efforts to mobilize political support, spear-

head reform, and engage with donors and other global partners can coalesce. AMCOW's capacity to help mobilize political will for reform and progress in the water sector should be crucial to the success of MDG related efforts in the region.

The Rural Water Supply and Sanitation Initiative

In response to inadequate access to water supply and sanitation in Africa, and to the relative bias towards financing urban water and sanitation, the African Development Bank (ADB) has developed the Rural Water Supply and Sanitation Initiative. The Initiative is intended to be a concrete contribution to meeting the MDG targets for water supply and sanitation.

The purpose of the Initiative is to accelerate access to sustainable water supply and sanitation in rural Africa, within the framework of the MDG targets and the Africa Water Vision.[3] This would be achieved through:

- developing fast-track mechanisms for preparation and implementation of programmes to extend and sustain rapid coverage of water supply and sanitation services to rural areas;
- promoting technologies that are appropriate, based on beneficiary consensus concerning the acceptable level of service, ease of implementation, and local skills and knowledge for their operation and maintenance;
- mobilizing higher levels of official development assistance (ODA) and promoting and supporting local initiatives for funding rural water supply and sanitation.

The Initiative's targets are to provide access to drinking water supply and sanitation to 66% of Africa's rural population by 2010 and to 80% by 2015 (the figure is now 34%).

These targets are set as overall figures for the continent as a whole. The average annual investment required in the seven years up to 2010 is expected to be about US$ 1.4 billion. Thereafter it will be about US$ 940 million.

Following extensive consultations at the country level, appraisal reports have been developed for the five pilot countries (Mali, Rwanda, Ghana Ethiopia and Uganda) in which the Initiative will commence. National action programmes are to follow soon. The Initiative is scheduled to begin formally in early 2004.

NEPAD water infrastructure programme

Among the goals of the New Partnership for Africa's Development (NEPAD) in the area of water are:

- planning and managing water resources as a basis for national and regional cooperation and development;
- sustaining ecosystems, biodiversity and wildlife;
- addressing the threat of climate change;
- assuring enhanced irrigated and rain-fed agriculture.

To these ends, NEPAD proposes to:

- work on multipurpose water resource projects such as the Nile Basin Initiative[4] and plans being studied by the Southern African Development Community's Water Secretariat for use of the Congo River;
- establish a planning group on mitigating the negative impact of climate change in Africa;
- collaborate with the Global Environmental Sanitation Initiative[5] in promoting sanitary waste disposal methods and projects;
- support the UN Habitat programme on water conservation in African cities.

The African Development Bank has been designated as lead agency for the development of the NEPAD infrastucture programme, including for water. In that capacity the ADB has worked with the NEPAD Secretariat to develop a short-term action plan, to be implemented over five to seven years. The plan consists of:

- project proposals to support seven river basin development organizations;
- support for a West African integrated water resource management (IWRM) action plan;
- water resource management in Central Africa;
- support for the development of national IWRM policies in all countries of Africa;
- a rural water supply and sanitation programme in the Niger basin;
- activities to combat drought and desertification in North Africa;
- water resource assessment in the 14 member countries of the Southern Africa Development Community;
- implementation of the hydrological observation system in the seven Intergovernmental Authority on Development countries in the Horn of Africa;
- strengthening of the interstate forecasting capacity of the Niger Basin Authority.

Most of the projects under the short-term action plan are under preparation. A medium and long-term action plan is also in an advanced state of preparation, with the assistance of the ADB. Activities of the NEPAD water programme will be implemented in close consultation with AMCOW.

The African Water Facility

The concept of the African Water Facility was developed by the African Water Task Force[6] and subsequently discussed in many forums. It has received donor support. The Netherlands and Canada have indicated their readiness to provide financial support, while Norway, Sweden, Denmark, the European Commission and Germany have expressed interest. The Facility also has the backing of the Camdessus Panel (which included it in an annex to its report), AMCOW and other organizations. AMCOW has assumed political leadership of the facility and has requested the ADB to host it. The ADB, which has accepted in principle, is making the final preparations for this arrangement with a view to ensuring that the Facility takes off in early 2004.

The concept of the Facility is predicated on the realization that huge levels of financial resources, many times the amounts currently expended, will be required to achieve the MDG targets of those of the African Water Vision. For example, it is estimated that using the most basic level of service and technology, meeting the target of the Rural Water Supply and Sanitation Initiative would require additional investment of about US$ 1.2 billion per year until 2015. Clearly the level of financing needed is well beyond the scope of any single group of stakeholders.

Once its office has been set up at ADB headquarters, the facility will start to mobilize financial resources from the international donor community to finance programmes and projects in two broad areas:

- The first is helping to create or strengthen the necessary policy, regulatory and institutional environment in African countries, so as to reduce obstacles and attract the massive financial investment needed from the public and private sectors, communities and donors. The Facility would focus intervention at the subnational, national, regional and river basin levels in such areas as IWRM planning, capacity building, policy and institutional reform, regulatory instruments and monitoring capacity, environmental management planning, shared river basin management, project and programme preparation, and knowledge development.
- Second, the Facility would attract additional resources for direct, strategic investments in water

ROGER DOMINIQUE/UNESCO

A child in Ethiopia.

L. GOODSMITH/UNITED NATIONS CHILDREN'S FUND (UNICEF)

Washing dishes with water and sand, Mauritania

infrastructure. Such investments would focus on programmes that are critical for facilitating other investments and that would operate in tandem with programmes on the regulatory environment, within a framework of "learning by doing." This is based on the premise, discerned from experience, that policy, regulatory and reform programmes are more valuable if implemented in the context of specific investment programmes rather than as stand-alone projects. Specific capital investment programmes would be identified in consultation with the governments of African countries and communities.

Conclusion

Meeting the MDG targets for water and sanitation in Africa will require a massive coordinated effort. The critical components of such an effort include:

- an integrated approach to water resources development and management;
- a huge effort to mobilize the necessary political support in order to achieve good governance;
- large-scale capacity and institutional building;
- effective collaboration with stakeholders at the community, local, national, regional, basin and global levels;
- mobilization of financial resources from all possible sources.

Above all, it implies doing things differently and more effectively than has been the case heretofore. While the initiatives described above try to embody most of these paradigms, it is clear that they must be part of a much larger effort if they are to succeed.

Notes

1. WHO-UNICEF, *Global Water Supply and Sanitation Assessment 2000 Report.*
2. P.H. Gleick (ed.), Water in Crisis: A Guide to the World's Freshwater Resources, Oxford University Press, New York, 1993.
3. The African Vision was developed as a contribution to the World Water Vision and framework for action, presented at the second World Water Forum (The Hague, 2000). The vision is of an Africa in which there is "equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation and the environment." One of its aims is to reduce the proportion of Africans without access to safe and adequate water supply and sanitation by 95% by 2025.
4. Launched in February 1999. This is a regional partnership in which countries of the Nile basin work for the long-term development and management of the Nile waters.
5. Led by an international steering committee under the umbrella of the Water Supply and Sanitation Collaborative Council. Its aim is to raise awareness of sanitation and hygiene behaviour worldwide.
6. The African Water Task Force was created in November 2001 as an informal organization to help prioritize African water issues at the global and regional levels. Current membership is drawn from the African Development Bank, the UN Economic Commission for Africa, the African Union, the World Bank, the Global Water Partnership, the Nile Basin Initiative Secretariat, the International Water Management Institute, the West African Ministerial Initiative, the Water Utility Partnership, the World Water Assessment Programme, the African Water Forum, FAO, UNEP, and government representatives from the Netherlands, South Africa and Ghana.

Selected references

Publications

- African Development Bank (ADB), UN Economic Commission for Africa (UN-ECA) and Organization of African Unity (OAU), *Safeguarding Life and Development in Africa: A Vision for Water Resources Management in the 21st Century*, Addis Ababa, 2002.
- African Development Bank (ADB), *Rural Water Supply and Sanitation Initiative: Framework for Implementation* (draft), Tunis, 2003.
- African Ministerial Conference on Water (AMCOW), *Reference Documents*, Cairo, February 2003.
- World Health Organization (WHO)-UNICEF (2000) *Global WSS Assessment Report.*

Web sites

- Africa Water Vision: www.worldwatercouncil.org/Vision/Documents/AfricaVision.PDF
- African Development Bank: www.afdb.org
- African Ministerial Conference on Water (AMCOW): www.africanwater.org
- African Water Facility: www.uneca.org/panafcon
- Millennium Development Goals: www.un.org/ millenniumgoals
- New Partnership for Africa's Development (NEPAD): www.nepad.org ◆

The potential for private sector partnerships to protect marine/coastal areas through national action programmes

Erin Marie Hyland, consultant, Wassenaaresestraat 46a, 2596 CJ The Hague, The Netherlands (erinmariehyland@hotmail.com)

Summary

There is a fragile relationship between the growth of coastal economic activity and the state of the marine/coastal environment. Where industry expands, the health of marine/coastal ecosystems generally deteriorates. Land-based pollution causes much of the damage. For the tourism industry, especially the island sub-sector, environmental damage in turn weakens the industry. The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities seeks to alter this relationship. It outlines a process for effectively addressing land-based contaminants. Future implementation will rely heavily on partnerships, especially those initiated by or involving the private sector.

Résumé

La relation qui existe entre le développement de l'activité économique côtière et l'état de l'environnement marin et côtier est extrêmement fragile. Là où l'industrie se développe, généralement la santé des écosystèmes marins et côtiers se détériore. La pollution d'origine terrestre en est en grande partie responsable. Pour le secteur du tourisme, en particulier le sous-secteur insulaire, les atteintes à l'environnement portent à leur tour préjudice à cette activité. Le Programme d'action mondial pour la protection de l'environnement marin contre la pollution due aux activités terrestres s'efforce d'inverser cette relation. Il propose une méthode pour résoudre le problème posé par les contaminants d'origine terrestre. Sa mise en œuvre future reposera pour l'essentiel sur des partenariats, en particulier ceux institués à l'initiative du secteur privé ou avec lui.

Resumen

La relación entre el crecimiento de las actividades económicas costeras y el estado del medio ambiente marino y costero es frágil. A la expansión industrial suele corresponder el deterioro de los ecosistemas marinos y costeros. La mayor parte del daño es causado por la contaminación derivada de actividades realizadas en tierra. En el caso de la industria turística y especialmente en el subsector de las islas, el daño ambiental debilita a su vez el desarrollo de la industria. El Programa de Acción Mundial para la Protección del Medio Ambiente Marino de las Actividades Realizadas en Tierra tiene por objetivo modificar el patrón de esta relación. A este fin, ha diseñado un proceso para ocuparse eficazmente a los contaminantes originados durante las actividades realizadas en tierra. La ejecución de este proceso dependerá en gran medida de las alianzas que puedan establecerse, principalmente aquellas que sean iniciativa del sector privado o que impliquen su participación activa.

Imagine a plane descending over turquoise water to land beside a sandy beach. Aboard, a couple gazes down, remembering their honeymoon ten years before in this pristine tropical paradise. Upon landing, they grab their bags and dash through customs. Within minutes of checking into the hotel they are running towards the beach, snorkel masks in hand. Plunging into the water, they resurface and suddenly find litter floating all around them. Swimming out to the reef where they had previously been immersed in brightly coloured fish and a variety of corals, they are dismayed by the absence of life resulting from coral bleaching. In only ten years what had offered the newlyweds a vibrant escape has deteriorated and now offers only disappointment and dismay. Worse yet, within days the couple's anniversary trip will become even more unforgettable when they fall ill with an infection contracted while swimming.

Fortunately, global realization of the need to better protect the marine/coastal environment is forcing an increase in discussions and a growing call for action. Integrated water resource and coastal area management (IWCAM) is being emphasized as a priority for international environmental action to reverse the degradation of freshwater and marine ecosystems occurring worldwide. In 2003, in recognition of the impact activities in coastal areas have on the state of the marine environment, the 22nd UNEP Governing Council highlighted protection of global water resources (including the need for government attention to coastal areas) in collaboration with regional institutions. This call is especially timely given the current thrust of efforts to further implement the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).[1]

Such implementation relies on the formation of political, institutional and financial partnerships. Broad stakeholder involvement is vital if efforts are to be successful. The political, private, academic, NGO and public sectors must take responsibility for problems and make commitments to rectify them. To ensure that actions to mitigate land-based pollution are sustainable in the long term, these sectors should also collaborate to develop effective systems for implementing and enforcing policies.

"Partnership formation" is the current buzz phrase within the international community. It is a major focus and outcome of the World Summit on Sustainable Development in Johannesburg in 2002. Ongoing work actively seeks to expand stakeholder involvement beyond governments and multilateral organizations, and to create avenues through which other players can have a stronger role. Public/private partnerships and the role of the private sector are increasingly mentioned. The Hilltops-2-Oceans (H_2O) Partnership Initiative, one of many initiatives launched at WSSD, relates directly to GPA implementation.[2] It stresses the link between freshwater and marine/coastal ecosystems and the need for the academic, private and public sectors to be actively involved in efforts to adopt two key elements of the GPA:

- National Programmes of Action for the Protection of the Marine Environment from Land-based Activities (NPAs);
- waste water emission targets.

Mirroring the continuity of natural water flow, actions must be comprehensive and connect all the people, activities and locations involved.

The number of partnerships addressing environmental sustainability is growing continually. Cooperation and communication, research and expertise, procurement of technology and engineering projects are all necessary components of successful NPAs, but they are capital intensive. Fortunately, effective partnerships increase the likelihood of well-resourced implementation. In many cases governments or multilateral/international organizations lead or initiate the partnerships, calling for increased private sector involvement. Industry-led or initiated partnerships are increasing in number, and their role in setting industry and consumer trends is incredibly valuable. However, there is still untapped potential and a need for greater involvement.

The island tourism industry

In the case of island tourism, especially, there are many opportunities for innovation cooperation. Due to the inherent interdependent relationship between tourism and the environment, stronger partnerships are needed within the industry to protect the natural resources upon which it depends. "The very nature of the mainstay product of the tourism industry – sand, sea and sun – highlights the fact that the industry is very dependent on coastal areas."[3] Furthermore, "the tourism industry can be seen as a network of economic and political agents, processes and resources."[4] Within this network are a large number of separate but linked economic activities, including guided tours and other recreational activities, construction, food production, energy and transportation, all delivering a complete package to visitors. The scale of the network, and the extensive number of stakeholders the travel and tourism industry represents, is reflected in the fact that the industry accounts for an estimated 10% of global GDP.

In addition, tourism plays a dominant role with respect to the economic development of many developing countries, especially small island developing states (SIDS). Since the tourism industry is a main source of employment and attracts much needed capital, it is in a strong position to influence policies and ensure that they benefit the marine/coastal environment. The tourism industry is therefore an interesting example to use in exploring the relationship between riverine and coastal economic activities and integrated coastal area and river-basin management, in terms of potential partnerships.

The concept of potential partnerships is not new to the tourism industry. Initiatives for sustainable/eco-friendly practices have already been established. Agenda 21 for the Travel and Tourism Industry, the Global Code of Ethics for Tourism, and the recently launched International Tourism Partnership are but three examples. Designation of 2002 as the International Year of Ecotourism increased the visibility of this trend and placed it in an international public spotlight. In fact, due to the ever-increasing number of initiatives and partnerships the tourism industry is proposing, the industry as a whole might be viewed as one of the global leaders in implementing comprehensive corporate responsibility and environmental sustainability policies. These are aspects to be considered and incorporated when countries go about devising their NPAs.

Tourism and development strategies are currently shifting beyond environmental protection to pro-poor tourism development. This method pursues a sustainable development strategy, but focuses efforts on addressing poverty alleviation.[5] As one objective of GPA implementation is to create innovative financial frameworks that bolster local economies and improve the overall well-being of the population, this new trend is in line with GPA efforts. New partnerships should consider this.

Often, strategies implemented to improve environmental sustainability or alleviate poverty have met with local success within the surrounding communities. The challenge remains of furthering activities and strategies beyond initiatives isolated within the industry, or individual facilities, and incorporating them in comprehensive national planning and policy schemes. Large-scale partnering and collaboration between all relevant stakeholders, especially those within the tourism network, will have a greater impact in reversing deterioration of the coastal/marine environment than any number of actions taken independently.

Land-based pollution and island tourism

The network of agents and processes in the island tourism industry also represents a web of potential pollution sources and pollution victims situated in the coastal as well as inland and upstream regions. The interdependent, cyclic relationship between the tourism industry and the environment is fragile. It requires precautionary and preventative action. Natural resources attract visitors, causing industry growth; this in turn increases the amount of waste and resulting pollution, leading to deteriorated environmental quality, which then causes the number of tourists to decrease. Without remediation and careful planning, the conditions encountered by the vacationing couple imagined at the beginning of this article will only become more common.

A variety of contaminants and activities threaten the marine/coastal environment. Sewage, often identified as the primary pollution problem in coastal areas, is especially characteristic of this cyclic relationship. High bacteria and pathogen loads can necessitate beach closures. Regions that develop a reputation for unsafe bathing waters risk long-term damage to their appeal to tourists. Development within the industry itself often exacerbates the problem. Increased tourist numbers lead to higher sewage levels, which existing infrastructure often cannot manage. Similar problems are posed by litter or solid waste.

Persistent organic pollutants (POPs), generally arising from agriculture but also from industrial production, adversely impact marine/coastal ecosystems. Pesticides constitute a threat to the environment and human health. Industry members that depend upon the strong attraction of natural resources are therefore especially at risk from unregulated practices. The link between exposure and food ingestion also places the food service industry in danger.

Sediment mobilization, and the physical alteration and destruction of habitats, also illustrate the tourism-environment cycle with their threat of damage or destruction of fragile ecosystems such as wetlands, lagoons, estuaries, mangroves and reefs. Improper land use and planning, often related to siting of tourism facilities, construction, mining, forestry and other activities, can either reduce or augment natural sedimentation rates. In each case there are negative consequences for the marine/coastal environment. And the cruise industry, a sub-sector of island tourism, presents a high risk when planning of ports and harbours does not sufficiently look at potential marine/coastal risks.

Existing recommendations for partnerships

There is a large body of literature in which the cyclic relationship between tourism and the environment is discussed. Many recommendations have been made for sustainable tourism development. Two recent publications have identified partnerships as one of the important principles to follow when pursuing successful environmental protection and poverty alleviation plans.

Recommendations in the 2003 UNEP/CI report on tourism's global footprint call for the private sector to "innovate processes and applications through new technologies and partnerships to minimize impacts on sensitive ecosystems and to contribute effectively to the conservation of biodiversity." Other recommendations include asking that this sector "make the commitment to educate staff and customers about the impacts of tourism on biodiversity and on local, traditional, and indigenous people" and "cooperate with governmental and non-governmental organizations in charge of protected natural areas and the conservation of biodiversity."[6]

Key principles for pro-poor tourism development, too, have identified the need for partnerships. Involvement of community associations, NGOs and the private sector is important for identifying industry niches that the low-income segment can fill, and for connecting them with mainstream industry activities. Partnerships for personnel training, marketing and outreach are also important.[7]

Expanding such recommendations to work in addressing NPA implementation will allow for more complete planning to better protect the coastal/marine environment.

The Global Programme of Action as a base upon which to build

International political recognition of the severity of the problem, as well as mechanisms leading to eventual mitigation of land-based pollution, are well-established. The GPA, adopted at the Washington Conference in 1995 and reaffirmed at the First Intergovernmental Review of the GPA in Montreal in 2001 and at the WSSD in Johannesburg in 2002, calls on sovereign states to develop NPAs that establish, through stakeholder consultation, an effective process for identifying, prioritizing and mitigating land-based pollution of the coastal/marine environment. The process is outlined and is adaptable to individual countries' needs, but political and financial commitments are required to implement work on the ground. To this extent, opportunities for partnerships involving industry are numerous, and the GPA offers a base plan for a complete process from which initiatives can be launched and adapted as needed.

Initiating partnership formation

Where the island tourism industry plays a dominant role, it is in a position to assist with this process and to influence policy and attitudes in favour of marine/coastal protection and to strengthen implementation of related partnership initiatives. In countries where effective NPAs or

IWCAM polices are lacking, the island tourism industry can use its influence to increase awareness and the demand for action. It can also lend political and financial support to development and implementation processes.

Building political demand

Initiation of NPA development and implementation requires broad political support. Stakeholder recognition and an understanding of the severity of the risk of land-based marine pollution to the environment and to countries' social and economic well-being is essential. Government and industry leaders, as well as the general public, need to be educated about the threats their actions pose to the coastal/marine environment and ways to reduce these threats. A general agreement to prioritize efforts to stop land-based marine/coastal pollution is urgent, especially in countries where tourism is the main economic activity.

In areas where the tourism industry relies heavily upon natural resources, and where it directly or indirectly employs a high percentage of the population, it might explore education campaigns as one approach to fostering political demand for NPA. Island tourism has much to gain from successfully raising awareness. By initiating such campaigns through workplace training, or collaborating with NGOs or local academic bodies on larger projects, the island tourism industry could take proactive steps towards protecting its interests while looking out for community well-being.

Designing legal, institutional and financial frameworks

Once the political demand to develop an NPA exists, legal, institutional and financial frameworks need to be designed. Although the government has the primary responsibility for this process, the systems adopted are more likely to be effective and positively received when stakeholder input, needs and concerns are incorporated. A formal consultative process, as well as an official mechanism for stakeholders to play a role in creating the frameworks, might be considered. Stakeholder workshops and multisectoral steering committees are typically involved in NPA development.

When the foundation for the NPA is laid, a balance needs to be struck among industry, public and environmental interests. Tax schemes, incentives, fee-for-use and other innovative financial frameworks should encourage economic growth, but not at the expense of the community's health. If well-designed, these frameworks can promote partnerships and collaboration and reward efforts that support sustainable development.

A progressive legal system might positively reinforce private sector efforts and encourage further industry initiatives by rewarding compliance with voluntary initiatives or incorporating successful initiatives in the legal frameworks. Green tax schemes that recognize efforts to use energy- or water-efficient and renewable resources in facility design and construction might be built into legislation. Similarly, tax benefits might be offered in exchange for education and employee training programmes that stress ecologically sustainable behaviour and that teach NPA principles, with an emphasis on local involvement and awareness, in the context of GPA efforts.

Additional rewards might include funding support or incentives to encourage industrial development that actively assists local community development. Employment or purchasing programmes that keep revenue local, or training programmes that build local human resource and technical capacity, are possible options. The large scale of the tourism industry, even within the island sub-sector, means that the frameworks designed must respond to a diversity of needs. It also means that a lot of potential exists for innovation and flexibility.

Zoning and land use policy

Policies that outline effective land use and zoning are an important component of successful NPAs. Especially in SIDS, where available land is often scarce, demand and competition for development can be fierce. Devising a system in which land use is evaluated and assigned in order to balance community, economic and environmental needs is a challenge, but it is vital to industry and community survival. Rather than haphazard, arbitrary siting of mixed activities within available space, or allowing tourism facilities to encroach dangerously on fragile beaches and dunes, space allocation needs to consider environmental health, aesthetics and economic needs to find the least damaging road to economic prosperity.

Regional analyses that utilize geographic information systems (GIS) and other technologies to denote economic zones and define appropriate land use activities for specific areas could potentially assist in strengthening economic activity without detrimentally impacting the coastal/marine environment. Analysis findings could aid a clearer understanding of the relationships between tourism, agriculture and other industrial activities as they pertain to and impact on each other and the local population.

Local people often rely for survival on the same areas and resources as the tourism industry and therefore share an interest in protecting them. These people must be consulted and included in NPA and development work. Through partnering with the community, the island tourism industry can help identify sustainable activities and the carrying capacities of coastal areas. Various approaches to protect areas might be pursued. One basic example could involve exchanges according to which, for example, the community agrees to land preserves or restricted resource use in exchange for a proportion of tourism revenue and/or employment and training opportunities that are better at alleviating poverty than traditional practices.

Market identification and promotion

Offering local communities viable economic alternatives to traditional practices is key to gaining their support for NPAs, and to deterring practices that could harm the environment. Private sector expertise in market analysis, consumer tastes, niche market identification and advertising is a valuable tool that could benefit the development of viable products and markets locally. In this way, everyone stands to gain by working with community organizations and the general population in order to identify their strengths and abilities and place them in the context of existing market needs.

The mainstream island tourism industry could also proactively increase the visibility of informal local activities. Promoting local services and products to visitors might help lessen tourist seclusion in resorts where they are isolated from the local community.

Reducing contaminant loads through partnerships

Numerous opportunities exist to reduce contaminant loads through working partnerships. If approached creatively, they may result in more cost-effective means of mitigation. Sewage and POPs are specific cases in which priority contaminants could be successfully addressed.

Effective waste water treatment is often a costly infrastructure project. However, the formation of partnerships could help overcome this barrier. Industry commitment to and advocacy of the adoption of waste water emission targets will increase the likelihood of their implementation. Among other options, ecological alternatives could be explored at locales where health regulations and land availability permit. One possibility could involve partnering municipal or tourism facility waste treatment with the agriculture industry, with treated waste water and sewage being recycled.

Collaborative efforts and partnerships between the tourism and agriculture industries have the potential to reduce POPs. Decreased use of harmful pesticides, and improved farming techniques to lessen runoff, would improve bathing water quality and marine/coastal ecosystem health. Moreover, produce would then be safer to eat and more attractive to buyers. Agreements between restaurants, hotels and other tourist venues, NGOs or academic institutions and local producers might be reached to carry out awareness campaigns that highlight pesticide risk and teach more effective, sustainable farming techniques. Incentives could include access to tourist markets through local purchasing schemes and promotion of produce within resorts.

Stakeholder consultation, and identification of problems, carried out during NPA development can provide the basis for recognizing the potential of innovative partnerships. In protecting its own interests, as well as the interests of the local community (i.e. its employees) and the marine/coastal environment, the island tourism industry could take the lead in acting on findings and initiating efforts to implement the NPA.

Moving forward through partnerships

The international community acknowledges the need for more effective partnerships to reverse land-based marine/coastal pollution and implement NPA/GPA efforts. Large-scale development projects, led by multilateral/international organizations, are ensuring that these issues are addressed

in their work. The potential for, and importance of, action within the island tourism industry is increasingly noted in this work. Manuals to encourage and outline strategies for industry action are being produced by bodies such as the UNEP Caribbean Environment Network.[8]

The tourism industry itself, especially the island tourism sub-sector and affiliated activities, is continually taking greater responsibility. The industry's influential position, reflecting its economic dominance in many developing countries, presents an opportunity and entails the responsibility to take appropriate and necessary steps to protect the marine/coastal area, especially from land-based pollution. The island tourism industry should take advantage of its potential to initiate partnerships and proactively look towards identifying new innovative strategies for collaboration.

With greater collaboration comes an increased likelihood of achieving international goals for protection of the marine/coastal area globally. Further GPA implementation, through NPA development on a broader scale, will help ensure that this occurs. The private sector is therefore called upon to maintain its support and further collaborate wherever possible.

Notes

1. See www.gpa.unep.org; www.unep.ch/seas/main/partners/gpa.html.
2. See hilltops2oceans.org.
3. UNEP/Conservation International, *Tourism and Biodiversity: Mapping Tourism's Global Footprint*, 2003.
4. Ibid. (Also see UNEP, *The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities*, 1995.)
5. Neto, Frederico, A new approach to sustainable tourism development: Moving beyond environmental protection, in *Natural Resource Forum*, 27, pp. 212-222.
6. UNEP/Conservation International, op. cit.
7. Neto, op. cit.
8. See cep.unep.org.

Dams and nature: negotiating enough water for life

Achim Steiner, Director General, IUCN – The World Conservation Union, and Ger Bergkamp, Co-ordinator Water and Nature Initiative, IUCN – The World Conservation Union, Rue Mauverney 28, 1196 Gland, Switzerland (achim.steiner@iucn.org; ger.bergkamp@iucn.org)

Summary

The World Commission on Dams has proposed that future decision-making be based on five core values: equity, efficiency, participatory decision-making, sustainability and accountability. It has also proposed addressing seven strategic priorities. This article examines the application and boundaries of the strategic priority that focuses on "sustaining rivers and livelihoods." A key element of this strategy is the establishment of "environmental flows", which leave sufficient water in rivers for downstream communities, economic interests and ecosystems. Environmental flows can only be established by combining scientific information with a transparent negotiation process. Appropriate legal and incentive mechanisms also need to be put in place.

Résumé

La Commission mondiale sur les barrages a proposé que les prises de décision soient à l'avenir fondées sur cinq valeurs de base : équité, efficacité, processus décisionnel participatif, viabilité et responsabilité. Elle a également proposé d'adopter sept priorités stratégiques. L'article s'intéresse à l'application et aux limites de la priorité stratégique relative à la préservation des cours d'eau et des moyens de subsistance. L'un des éléments clés de cette stratégie est l'établissement de " flux environnementaux " qui laissent suffisamment d'eau dans les rivières pour les populations, les intérêts économiques et les écosystèmes situés en aval. Ces flux environnementaux ne peuvent être institués qu'en combinant les informations scientifiques avec un processus de négociation transparent. Cela suppose donc également la mise en place de mécanismes juridiques et incitatifs appropriés.

Resumen

La Comisión Mundial de Presas ha propuesto que, en adelante, el proceso de toma de decisiones esté basado en cinco valores fundamentales: equidad, eficiencia, proceso participativo para la toma de decisiones, sostenibilidad y rendición de cuentas. Asimismo, ha propuesto la definición de siete prioridades estratégicas. En este artículo se analiza la aplicación y las limitaciones de la prioridad estratégica orientada al "mantenimiento de ríos y medios de sustento". Uno de los elementos clave de dicha estrategia es el establecimiento de "flujos ambientales" que permita el paso de suficiente agua de río para las comunidades instaladas río abajo, los intereses económicos y los ecosistemas. Los flujos ambientales sólo son viables cuando convergen la información científica y los procesos transparentes de negociación. También es necesario contar con mecanismos legales e incentivos adecuados.

Dams around the world have made an important contribution to development. The World Commission on Dams has concluded, however, that in too many cases an unacceptable and often unnecessary price has been paid to secure benefits from dam projects. The human and environmental consequences of existing dams and new projects need to be addressed. The framework proposed by the Commission provides an alternative to continuing the non-sustainable practices of dam development, construction and operation.[1]

The Commission has also proposed that future decisions be based on five core values: equity, efficiency, participatory decision-making, sustainability and accountability. These form the basis for decisions by governments and civil society on the very meaning, purpose and pathways for achieving development. Essential to this is the reconciliation of competing needs and entitlements to water that underlie the conflicts around dams.

The core values can provide a basis for defining a common strategy. This strategy should be based on recognizing existing rights and entitlements, and assessing the risks involved in dam development. Thus the ability to determine who should sit at the table, and which issues need to be discussed, will be enhanced.

The Commission has further proposed addressing seven strategic priorities. In this article we explore the application and boundaries of the

The Cumumana dam in Southern Mozambique.

strategic priority that focuses on "sustaining rivers and livelihoods" with a particular focus on Africa, where it is planned to build a considerable number of dams in the decades to come. A key element is the release of tailor-made environmental flows to help maintain downstream ecosystems and the communities that depend upon them. An environmental flow is the water regime within a river, wetland or coastal zone that maintains ecosystems and their benefits where there are competing water uses, and where flows are regulated. Environmental flows make vital contributions to river health, economic development and poverty alleviation. They ensure the continued availability of the many benefits that healthy rivers and groundwater systems bring to society.[2,3]

The price of not providing environmental flows should not be underestimated. It is increasingly clear that, in the mid and long term, failure to meet environmental flow requirements has disastrous consequences for many river users. In West Africa, for example, it is estimated that freshwater withdrawals will increase at least five-fold in the next 25 years. On the transboundary Niger River alone, nine large dams are planned and under development by individual countries. There is not much consultation between the countries involved. Throughout African river basins, downstream users are unlikely to remain unaffected by the consequences of the major infrastructure developments promoted through the New Partnership for Africa's Development (NEPAD).

Addressing the water needs of aquatic ecosystems and their users will therefore often result in reducing upstream water users' water withdrawals and consumption. Tough decisions will need to be taken in order to balance all needs and ensure the long-term health of entire river basins and the economic activities they encompass.

To start with environmental flows, all aspects of the river and drainage system need to be considered. This means looking at the basin from the headwaters to the estuarine and coastal environments, including wetlands, floodplains and associated groundwater systems. It also means considering environmental, economic, social and cultural values in relation to the entire system. A wide range of outcomes, from serving the needs of industries and people to environmental protection, must be considered. To set an environmental flow, it is necessary to identify clear objectives as well as water abstraction and use scenarios, with inputs from multi-discipline expert teams and stakeholder representatives.

Environmental flows should be based on informed choices by society concerning water allocations. No simple figure can be given for the environmental flow requirements of rivers, wetlands and coastal ecosystems. Much depends on stakeholder decisions and actions that will shape the future character and health of a river.

Environmental flow assessments can best be carried out within the context of wider assessment frameworks that contribute to river basin planning. These frameworks, which are part of integrated water resources management, assess the current economic and social situation, water abstractions and consumption, and river health. Building on stakeholder participation, they can include scenario-based evaluations of alternative flow regimes. A wide range of methods and frameworks for determining an environmental flow, setting management rules and monitoring their impact on river health are currently in use. Examples include the application of simple "rules of thumb" or of very sophisticated ecological modelling approaches.

Implementing environmental flows requires either active flow management (e.g. through adjusting dam operations) or a restrictive management regime (e.g. through reducing the abstractions for irrigation). When active flow management is applied, an entire flow regime can sometimes be generated, including dry season flows and floods. Restrictive flow management involves water allocation policies for leaving water in the river by controlling abstractions and diversions. Both types of intervention depend on water managers changing their current practices and will therefore need to be based on sound legal and societal support.

Making infrastructure work for people and rivers

Existing infrastructure was often not designed to release water for environmental flows. Many dam managers have not included environmental flow considerations in their operating rules until today. Environmental flows can be implemented with new and existing infrastructure. Dams are frequently the most significant modifiers of natural river flows, and changing their operation is an important aspect of implementing environmental flows. Policies and rules for dam operation determine the amount and timing of actual releases, including those for environmental flows. The design and operation of other infrastructure, such

Impacts of dams on the lower Zambezi and the Niger

Construction of the Cahora Bassa Dam on the Zambezi River in 1974 has seriously affected the Zambezi's river basin ecosystem. Maximum river flows have been halved by construction of the dam, from over 10,000m^3s^{-1} to less than 5000m^3s^{-1}. The Cahora Bassa Dam in Mozambique has drastically reduced the flooding of the downstream floodplain and delta. Immediate impacts of such a reduction include saltwater intrusion and changes in the sedimentation of coastal systems, with related effects on coastal geomorphology. The shrimp catch on the Sofala Bank was reduced from between 10,000-12,000 to 7900 tonnes over 12 years.

The community structure of the floodplain vegetation has also changed, with a substantial increase in trees. The productive, flood-dependent grasslands have been depleted of grasses, the favoured food plants of herbivorous mammals. Species such as the formerly abundant buffalo have practically disappeared from the delta. "Recession agriculture" in the floodplain has declined significantly. In the lower Shire River, the largest tributary of the Zambezi downstream of the dam, water levels have dropped to a point where navigation is affected.

Due to upstream developments in the Niger basin, the extent of the flood in the inner delta decreased from 37,000 km^2 in the early 1950s to about 15,000 km^2 in the early 1990s. Thus large parts of the inner delta are now only occasionally inundated. The annual supply of water, nutrients and sediments to the floodplain has been greatly reduced, seriously affecting the people who live their and their economic base.

See B.R. Davies and J.A. Day, Vanishing Waters, University of Cape Town Press, 1998; M. Chenje and P. Johnson (eds.), Water in Southern Africa, SADC/IUCN/SARDC, Maseru/Harare, 1996; A.M. Hoguane, The Influence of Freshwater from Zambezi River on the Shrimp Distribution and Availability in Sofala Bank, NETCAB/IUCN-ROSA, Harare, 2000.

Flooding to maintain the estuary mouth of the Great Brak River, South Africa

The Great Brak River has a small estuary, approximately 2.5 km long, situated on the southern coast of South Africa. The estuary mouth, which occasionally closes, is breached when river flow increases. The Wolwedans Dam on the Great Brak River was completed in 1989 amid serious concerns about its potential effects on the estuary. An environmental impact assessment involving the local community was undertaken during its construction, and a management plan was designed with the objective of maintaining the estuary in a healthy condition. Water was released to maintain open-mouth conditions in spring and summer and so maintain the estuary's ecological and recreational functioning.

The ongoing monitoring programme established included physical and ecological aspects. The results are used to evaluate and refine the effectiveness of the management plan. Initial indications are that the salt marshes and prawn and crab populations are healthy. The project's uniqueness lies in the creation of a management plan, monitoring of its effectiveness, and use of the results to refine and improve the original plan.

See P. Huizinga, CSIR, Stellenbosch, personal communication in R. Hirji, P. Johnson, P.Maro and T. Matiza Chiuta T. (eds.), Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa. SADC, IUCN, SARDC, World Bank, Maseru/Harare/Washington, DC, 2002.

as distribution canals and weirs, can also contribute to establishing environmental flows.

New dams provide good opportunities to implement environmental flows. In the planning phase it is important to ensure that dam and reservoir operating strategies conform to environmental flow requirements. Building flexibility not only to meet current standards, but also to accommodate future changes in regulation, use and climate, is crucial. Adequate provisions for environmental flows need to be made during the years of construction and reservoir filling. Trial releases over the first years of operation will be required in order to test flow regimes and reduce the inherent uncertainties in predicting river response to environmental flows.

Adjusting existing infrastructure can also have immediate positive effects. Many countries have a large number of dams that can be retrofitted, or where operation can be changed. Options for modifying releases from these dams depend on the type of dam, the provisions for releasing water, and the state of the key water control outlets and structures. Periodic re-licensing of existing dams provides an opportunity to establish environmental flows or update existing regimes. Greater focus on modernization and performance will help optimize management of existing dams and implement environmental flows.

Dams can also be decommissioned so as to restore environmental flows. The renewal or removal of a physical infrastructure that has outlived its economic usefulness is a normal consideration, and dams are no exception. Decommissioning a dam to restore environmental flows can involve permanently opening its gates, or even the dam's partial or full removal. However, while these options are preferable in some cases, it is clear that it is not appropriate for all dams and should not be undertaken without a full environmental impact assessment.

Financing environmental flows

Establishing environmental flows is not free. An analysis of the cost and benefits – including who gains and who loses – is an important prerequisite for any decision on an environmental flow. It helps identify the relevant stakeholders and leads to an understanding of the incentives for parties to participate, as well as defining how the poor can benefit from change. Moreover, it serves to establish the required money transfers, the potential sources of funding, and the necessary financial mechanisms.

High flows to stimulate spawning of the Clanwilliam yellowfish, Olifants River, South Africa

The Olifants River in the Western Cape of South Africa supports eight endemic fish species. The largest species is the Clanwilliam yellowfish, *Barbus capensis*. Two in-channel structures, a dam and a weir, in the middle reaches of the Olifants River have contributed to the decline in abundance of this species. In particular, the Clanwilliam Dam has harnessed the small floods that characterized spring and early summer flows in the river and were thought to have triggered the spawning of *B. capensis*. Small experimental floods were released from the dam in an attempt to trigger spawning. It was concluded that small floods released between October and January should increase the spawning success of *B. capensis*, but only if the temperature of the spawning site is 19°C and stable or rising. Successful spawning will not necessarily lead to higher numbers of fish later if temperatures of the released water are not maintained at appropriate levels for the development of the juvenile fish.

*See J. Cambray, J. King and C. Brauer, Spawning behaviour and early development of the Clanwilliam yellowfish (*Barbus capensis; Cyprinidae*), linked to experimental dam releases in the Olifants River, South Africa, in Regulated Rivers: Research and Management, 13 (1997), pp. 579-602.*

Financing environmental flows hinges on the acceptance of changes in the status quo. Investments in environmental flows will need to be justified by improvements in environmental, social or economic conditions within wider society rather than on the basis of the impacts felt by specific groups. Without benefits to society there will be little financial or economic rationale for undertaking and financing the required changes. High priority should be given to situations in which the direct benefits are clear (particularly for the poor) and where the applied methods are cost-effective and well-known.

Modification of existing incentives will be needed in order to motivate interest groups to change. Many existing incentives favour economic activities and thereby largely determine a system of water allocation. Understanding the relationship between the incentives and impacts of water substractions and use is a critical step in establishing environmental flows. Slowly influencing the economic framework, and creating the necessary social acceptance of environmental flows, could be preferable to immediately changing the existing set-up for water allocations.

Creating a policy and legal framework

To establish environmental flows, domestic legislation and administration is critical. Only a limited number of countries have recognized the non-consumptive use of water and developed special domestic legislation to provide for it. South Africa is one of the countries where allocation of water is recognized by law. The South African Water Act (1998) only recognizes two rights to water: for basic human needs (Human Needs Reserve) and for maintenance of rivers (Ecological Reserve). These amounts must be determined and secured before any other allocations can be made. A clear legal and administrative pathway to protect river flow is necessary before stakeholders will be willing to commit – or agencies will be prepared to fund – environmental flow projects. A serious attempt to manage for environmental flows will not occur unless clear policy decisions are taken at the appropriate level of government.

Previously in Africa there were few public policies or legal frameworks to deal with environmental flows. Many African nations are now signatories to international agreements such as the Ramsar Convention. Many are also revisiting their existing water policies and laws and updating them to include IWRM principles. Increasingly, these new policies and laws make explicit provisions to guarantee water allocations for maintaining rivers and downstream ecosystems. In addition to South Africa, examples include Burkina Faso and Tanzania.

Unfortunately, there is no "quick fix". Domestic legislation on environmental flows needs to be tailored to realities. Key principles or guidelines can assist the development of the required policies and institutional and legal frameworks. However, engaging local communities and making use of the knowledge and experience of locally elected officials is critical in tailoring laws and institutional arrangements to realities on the ground. Wherever possi-

ble, the best approach is to address environmental flows before water resources are over-allocated.

Policies and laws alone will not make rivers flow again. It will therefore be essential to establish a clear and robust system to facilitate effective implementation, compliance and enforcement. To develop domestic legislation, it is important to determine the scale at which environmental flows are to be established. Dealing with issues at the lowest appropriate levels will be necessary to implement a successful regime. Rights over access to water and use of water resources will need to be accommodated or adjusted. This is likely to involve the inevitable questions of if, how and by whom compensation might be payable when water rights are varied, and will require decisions on who might "hold" the environmental water "in trust." An adaptive style of management is needed, and liability issues should be addressed beforehand.

Acknowledgements

We would like to thank Niasse Madiodo, Tabeth Chiuta, Elroy Bos and Megan Cartin for their contributions to this article.

Notes

1. *Dams and Development. A new framework for Decision Making. The report of the World Commission on Dams*, Earthscan Publications, 2000.
2. G. Bergkamp, M. McCartney, M. Acreman, P. Dugan and J. McNeely, Dams, Ecosystem Functions and Environmental Restoration. WCD Thematic Review, in *Environmental Issues*, II.1, WCD, 2000.
3. M. Dyson, G. Bergkamp and J. Scanlon, *Flow – The essentials of environmental flows*, IUCN, Switzerland, 2003.

Achim Steiner was Secretary General of the World Commission on Dams. Ger Bergkamp participates in the Dams and Development Forum and is a member of the Steering Committee of the UNEP Dams and Development Project, a follow-up to the World Commission on Dams.

◆

The changing water cycle and the insurance industry

Andrew Dlugolecki, Director, Andlug Consulting, 17 Craigie Place, Perth PH2 0BB, UK (andlugt@hotmail.com)

Summary

Climate change increases the risk of physical damage to customers' assets and of the interruption of economic activity (e.g. due to flood and drought). Insurers have often taken the position that flood risk is uninsurable. While there is growing willingness to reconsider this position, insurance can only be one element of a systematic approach to flood risk. In developed countries the insurance sector needs to become more aware of risks and to engage with other stakeholders in a way that leads to sustainability. Public-private partnerships are essential in the developing world, where insurance does not really help redistribute the cost of major disasters.

Résumé

Le changement climatique accroît les risques de dommages physiques aux biens des clients et d'interruption de l'activité économique (par exemple, pour cause d'inondation ou de sécheresse). Les assureurs ont souvent adopté la position qui consiste à dire que le risque d'inondation n'est pas assurable. Si une volonté de reconsidérer cette position commence à se faire jour, l'assurance ne peut toutefois être que l'un des éléments d'une approche systématique du risque d'inondation. Dans les pays développés, le secteur de l'assurance doit prendre davantage conscience des risques et s'engager avec d'autres parties prenantes de façon à parvenir à la durabilité. Les partenariats public-privé sont essentiels dans les pays en développement où l'assurance n'aide pas vraiment à redistribuer le coût des grandes catastrophes.

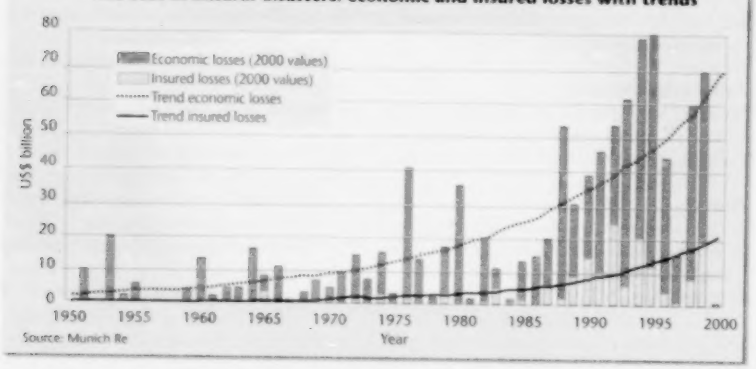
Resumen

El riesgo de que los activos de los consumidores sufran daños físicos y se interrumpa la actividad económica crece en la medida en que se desarrolla el fenómeno del cambio climático (por ejemplo, debido a las inundaciones o las sequías). En general, las aseguradoras se niegan a cubrir el riesgo de inundación. Aunque parece haber una mayor voluntad para reconsiderar esta postura, los seguros sólo constituyen una parte del enfoque sistemático para hacer frente a este tipo de riesgo. Es necesario que el sector seguros en los países desarrollados cobre conciencia de los riesgos y coopere con otras partes interesadas para alcanzar la sostenibilidad. Las relaciones entre el sector público y el sector privado son cruciales en los países en desarrollo, pues el hecho de contar con un seguro no contribuye a redistribuir los costos que implican los grandes desastres naturales.

The Third Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) declares that flooding is the "most widespread serious potential impact" of climate change on human settlements. This expected effect would stem from sea level rise, changes in tidal ranges and wave heights, and increased intensity of maximum precipitation inland, compounded by increasingly inadequate urban drainage systems. Wetter winters and drier summers are also expected in high latitudes, while drought will likely become more prevalent in continental interiors. In the case of extreme events generally, return periods are expected to collapse; that is, what was a 1:100 event in the mid 20th century (e.g. a "100-year flood") is now a 1:40 event and, by current forecasts, will be a 1:4 event by mid 21st century.

Furthermore, the gradually rising global trends cited in the IPCC reports actually underestimate the dangers. As the National Academy of Sciences in the United States has noted, regional climates have often changed very suddenly in the past, particularly as regards precipitation levels, leading to the collapse of entire civilizations. If such a phenomenon were to occur now, it could cause enormous damage to infrastructure such as roads and water and power supply. The costs of abrupt climate change are difficult to calculate, but a parallel is provided by looking at the difference in the cost of adapting to climate change with and with-

Figure 1
The cost of natural disasters: economic and insured losses with trends



out the assistance of climate predictions. For the global agriculture sector alone, this difference is estimated at US$ 150 billion.

Aggregating the economic costs of climate change worldwide is controversial. Gains for some are taken to cancel out losses for others. In fact, it is projected that more people will be harmed by climate change than will benefit from it, even in the case of small temperature increases, as river and stream levels will be more unpredictable and sea level will rise in many less developed countries (LDCs). About 10 million people are now at risk in coastal zones. This figure will likely reach 50 million plus by 2050, with the main exposure in Africa, Asia and small island states.

Higher temperatures and variable runoff will mean lower water quality. With respect to quantity, IPCC has projected that even without climate change 5 billion people would live in countries under water stress by 2025. Climate change will worsen the position of about 500 million of them.

Overall there will be adverse effects on human health, particularly for the poorest sections of society. One result could be substantial migration to wealthier regions. Many economic activities will be affected (including agriculture, navigation and fisheries), as will recreation, cultural heritage and ecosystems. In countries that rely on hydropower, or on the availability of cooling water for power plants, erratic water supply will lead to widespread brownouts. Rapid urbanization in low-lying coastal areas greatly increases the population and assets at risk, and the situation will be exacerbated by outdated drainage and other infrastructure.

In Japan, according to one estimate, the cost of adapting docks to higher sea levels may amount to US$ 110 billion. In Venice, where floods have become very common, the estimated cost of a recently approved flood defence project is over US$ 4 billion. Recent analyses show that proper planning can reduce adaptation costs considerably (e.g. for the US coastal zone, from US$ 90 billion to 6 billion). Of course large-scale engineering works are only possible in rich countries. Venezuela, for example, can afford neither to protect its oil fields nor to lose them.

Implications for insurance

Worldwide economic losses due to natural disasters appear to be doubling every ten years (**Figure 1**). On current trends, annual losses would near US$ 150 billion in the next decade. Indeed, at the current rate of increase these losses would exceed global GDP by about 2065. **Table 1**, which provides comparable figures for weather-related disasters only, shows that insured losses are rising even faster, putting greater demands on the insurance system to compensate victims.

Scientists believe most of the increase in losses until quite recently has reflected not climate change, but rather factors such as population growth, settlement patterns and the greater sensitivity of modern assets to water damage. The trend will accelerate with climate change: the severe floods, droughts, heat waves, fires and storms of the last few years are likely a portent.

If weather patterns continue to worsen as forecast by 2050, the risk faced by insurers (particularly reinsurers) will increase sharply. Suppose an insured facility faces a 1% chance of a US$ 1 million loss from an extreme flood and a 0.1% chance of a US$ 5 million loss from a catastrophic flood, implying a risk premium of .015. With a relatively small change in extreme events, say from 1% to 4%, and with catastrophic events occurring 1% rather than 0.1% of the time, the risk premium shifts by a factor of 6, from .015 to .09. (**Table** illustrates the arithmetical procedure.)

Table 1
Weather trends: great weather disasters 1950-2001 (decade comparison)

	Decade 1950-1959	Decade 1960-1969	Decade 1970-1979	Decade 1980-1989	Decade 1990-1999	Last 10 1992-2001	Factor last 10:60s
Number	**11**	**16**	**29**	**44**	**72**	**64**	**4.0**
Economic losses	41.2	54.1	79.4	126.1	425.4	362.0	6.7
Insured losses	-	7.2	11.5	23.0	98.9	79.3	11.0

Losses in US$ billion - 2001 values
as of 1 March 2002
© 2002 GeoRisks Research Dept., Munich Re

Is flood insurable?

Whether risks are insurable depends on four key technical factors:

1. whether the risk can be quantified;
2. whether there is undue influence by the insured party;
3. whether the insured risks are representative;
4. whether they are independent.

In addition, there are five commercial aspects: government policy; marketing; level of competition; insurer skills; and affordability. Each of these aspects is problematic when it comes to flooding.

To take the technical factors in turn:

1. A key difficulty in pricing flood risk is the insufficiency of historical data. To estimate a given return period, one ought to have data for 10 to 20 times that period (i.e. for a 1:50 event one would need at least 500 years' data).
2. Insured parties can influence the amount of losses through their degree of preparedness for a flood.
3. It is self-evident that those who know they are exposed to floods will be more likely to purchase insurance;
4. A flood is likely to affect many properties simultaneously.

As for the commercial aspects, if a government decides to include floods in a publicly funded civil defence system there is little scope for private insurance. Public systems usually embody the notion of "solidarity" – funding through general levies without regard to the risk borne by individuals. Those at risk will not buy insurance since they are being subsidized, and those not at risk will not buy insurance either.

Marketing is an important dimension. Without adequate distribution and consumer awareness of risk, the uptake of insurance will be low. After the US National Flood Insurance Program's first 30 years of operation, only 20% of those living in flood plains had availed themselves of the coverage offered.[1] (It should be noted that those populations most in need of flood insurance are often less well off, and so tend not to purchase financial products.)

Concerning the level of competition, price will be the dominant competitive factor where there are many insurers and minimal regulation. This will undermine attempts to ensure that the supply of flood insurance is stable. Supply will oscillate with flood events, and periods of oversupply will militate against dealing with the underlying physical hazard since to do so would require investment at a time when profit margins are low. Flood risks therefore persist or even worsen.

Insurer skills can be a material factor in the insurability of flood-prone areas, as relatively small physical differences in location or structure can make a great deal of difference in the risk for a given property. Skill in organizing damage recovery also counts for a lot, as delays or poor repairs can raise the cost substantially.

Finally, affordability of premiums is a problem for high-risk properties. Damage from a moderate flood

can cost many times the level of the average household insurance premium. In the United Kingdom, for example, an average property might be worth £100,000, with an annual premium of £250 for a full range of insurable risks. A typical flood claim is around £30,000. Thus, for a property in an area exposed to a flood risk of 2% (a 50-year return period), the flood loading would be £600 (2% of £30,000), raising the annual premium to £850, which many consumers would find unacceptable.

When this situation arises because there is a change in the perception of risk for a minority of properties, insurers will usually try to alleviate their terms for their current clientele, in effect providing a cross-subsidy. The problem becomes more difficult if there is a general trend towards riskier properties (e.g. because of land development policies) but this is not picked up at the same time by the insurance conditions. Such a situation will lead to instability in the insurance market, as some insurers "cherry-pick" the better risks, leaving other insurers with a worse than average book of business. In the end there will need to be a major revision of the flood insurance model within the entire country. In many countries, of course, insurers are so concerned about the potential of flood damage that even low-hazard properties are not insured against flood. Owners have to seek relief from the state, donations or their own resources.

An integrated property damage system

Traditionally, insurers have looked at the problem of flood as one of reducing their own liability. This means they simply modify their contract with the property owner (e.g. impose higher premiums or deductibles). They do not have any way to control the underlying risk using such approaches as flood defences or building material specifications.

Insurers use four strategies to deal with purely underwriting problems:

- They can limit the risk to themselves through selective underwriting or avoidance, i.e. refusing to insure high-risk properties. This is generally unpopular with customers and policy makers, but in the case of flood risk it may be inevitable.
- They can control the damage through such recent advances as the introduction of telephone help centres and networks of approved repair contractors. The increase in floods in recent years has also prompted the development of better techniques to minimize damage via a variety of drying-out methods.
- Having accepted the risk, insurers can transfer it to someone else. Traditionally this has meant reinsurance, but that option has become much more costly and less available because of the upward trend in disasters. Recovering damages from another party is difficult unless the risk was so obvious that the third party could be deemed grossly negligent (e.g. had ignored repeated occurrences or clear warnings).
- They can charge the correct price. But, as noted above, it is difficult to estimate the true risk of the hazard. And in a competitive market, where insurers fight for market share, any insurer raising premiums enough to cover the true risk would probably lose a lot of business.

Table 2
Example of the effects of changes in extreme event probabilities on reinsurance premiums

Event type	Normal	Extreme	Catastrophe	
Event cost	0	1	5	
Period	% frequency			Expected cost
Now	99	1	0.1	0.015
2050	95	4	1	0.09

Expected cost = extreme event cost x frequency + catastrophe event cost x frequency

Source: author

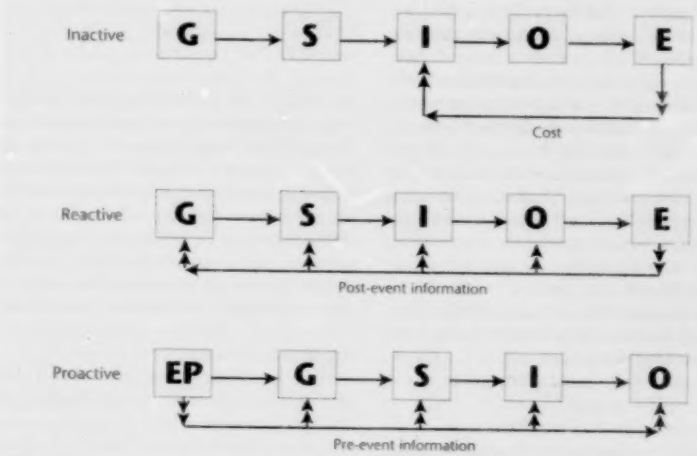
In principle, it is better for insurers to help reduce risk rather than leaving this task for others. In the short term this lowers claims costs; in the long term it underpins the stability and growth of the market for insurance. To reduce risk, insurers need to collaborate with other stakeholders in the risk universe. **Figure 2** shows how the UK insurance market's attitude to flood risk is changing. Initially insurers were inactive, paying little attention to the issue and simply settling claims as they arose. They made little if any use of the information that came their way from claims handling. As the volume of claims increased and insurers slowly became aware of the issue of climate change, they moved into reactive mode, collecting claims data, communicating their concerns to other stakeholders (e.g. regulators, planners and lenders) and adopting a mix of the four purely underwriting strategies to control the problem.

The Association of British Insurers completed a study of river flooding just two weeks before serious flooding in the autumn of 2000. Their report warned that there was a much higher damage potential than had been realized. This prediction was confirmed almost as soon as it was published. UK insurers have now entered a proactive phase, insisting that flooding must be recognized as a major hazard and guarded against when regulations are formulated and building projects are approved. This shift has important implications for the way insurers operate. To get the maximum benefit from a proactive stance, they must invest time in interaction with policy makers. In the UK this role is largely carried out by the Association of British Insurers, which represents the majority of underwriters and has established a leadership role in the flood risk arena.

Behind the collective position, individual insurers are developing their own strategies. For most this means being more selective with respect to the risks they accept, and formulating new contractual terms for the policies they do issue, particularly in pricing and deductibles. A key factor is improved information about individual properties. Since the official flood risk maps are too vague, proprietary maps using satellite or airplane photography are being prepared.

It seems clear that a fresh approach to natural

Figure 2
Progress towards an integrated property damage system



Source: author

hazards is needed. A key element will be collaboration between the public and private sectors, probably through industry associations. The Association of British Insurers has a strategy for weather risks that involves identifying key issues (e.g. subsidence of clay soil, riverine and coastal floods, planning policy for real estate, winter storms), quantifying the risk, specifying the critical aspects of exposure and vulnerability, and providing this information to government so that design standards and flood defence regimes can be improved. In a US initiative, after experience showed that hurricane damage was worse in substandard buildings, insurers funded the training of government building inspectors to insure quality control during construction.

Figure 3
A structured approach to financing recovery

The situation in developing countries

Insurance does not really help redistribute the cost of major disasters in poor countries. A large proportion (as much as 90%) of the cost is not insured, and so is borne by the victims or disaster relief agencies. Distribution costs are high, particularly for small purchasers. The product is therefore often seen as expensive or irrelevant. Insurance is a "grudge" purchase (i.e. one with negative connotations for the buyer), a problem compounded by the complexity of contracts.

Developing countries are vulnerable to the volatility of the insurance market for two reasons. First, the basic insurance contract is fairly short-term (usually 12 months for non-life policies). This protects the insurer from changes in the operating environment, but tends to be associated with alarming swings in market conditions. Second, the industry is prone to cycles in provision of capital, resulting in "feast and famine" phases in the market and discouraging long-term risk bearing.

The World Bank has become involved in this issue. More and more of its development funding has had to be diverted to disaster relief and reconstruction – so much so that it is de facto the world's third largest reinsurer. Accordingly, it has proposed a structured approach to financing recovery from floods and other disasters (**Figure 3**). The plan would segment the economy into sectors, each serviced by the most appropriate primary form of risk finance:

- private insurance for the wealthy and industry;
- simple public catastrophe cover for small and medium-sized enterprises;
- self-insurance for public infrastructure;
- relief aid for the poorest.

These four funds would be supported by a regional or national catastrophe pool, backed up by multilateral financial institutions like the World Bank and then, in turn, by the international reinsurance market and perhaps the global capital markets. For the segments that are not commercially viable, insurers could provide disaster recovery services, risk administration and training on a fee/advisory basis, on the model of the US National Flood Insurance Program.

The way ahead on climate change

Climate change was discussed at the annual roundtable of the Geneva Association, a forum of the world's 80 largest insurers, in June 2001. It was agreed that the key issues were:

- communication: within the industry, to policy makers and to stakeholders;
- use of commercial links to leverage strategies (e.g. along the supply chain and through socially responsible investment into mainstream investment thinking);
- changing the short-term nature of performance focus;
- accessing the larger capital markets to provide more capacity for catastrophe cover.

These conclusions have been endorsed by the UNEP Finance Initiative. As practical ways forward, UNEP FI has recommended that there be three task forces on awareness raising, quantifying the effects of climate change on equity valuation, and monetizing the environmental aspects of project appraisal. Progressive insurers are adopting far-reaching plans individually. These insurers are seeking to identify the key hazards in more detail through research and data collection. They are also endeavouring, by refining existing processes or innovating, to raise awareness in other stakeholders (particularly government), to work with these stakeholders to manage weather hazards such as floods, and to provide essential cover and recovery services.

Successful businesses recognize that climate change is a significant factor in planning. New information needs to be assessed and disseminated to staff in actionable terms. There could also be opportunities to gain or reinforce a leadership position through a proactive stance on the issue while improving corporate profitability. By improving their environmental management internally, and ensuring that their investments support climate-friendly activity, insurance firms can play a part in slowing the process of climate change. The most active companies also lobby policy makers at the international level (through bodies like the UNEP Finance Initiative) for more urgency in dealing with climate change.

Notes

1. Congress established the NFIP in 1968. The nearly 20,000 participating communities adopt and enforce flood plain management ordinances to reduce flood damage. The NFIP makes federally backed flood insurance available to homeowners, renters and owners of businesses in these communities. Through this programme, flood damage has been reduced by nearly US$ 1 billion per year. In addition, buildings complying with NFIP building standards suffer some 80% less damage overall than those that are not in compliance. In an average year the NFIP is self-supporting; operating expenses and insurance claims are paid not by taxpayers, but through premiums. In years of heavy losses the NFIP can borrow from the US Treasury, but it must repay the loans with interest.

2. The insurance industry interacts with all other productive sectors of the economy, as well as end-users. It provides them with risk management services and invests money in them or on their behalf. It is potentially a powerful instrument for cultural change owing to its ability to incorporate principles of sustainability into services for all these clients. Insurers also channel large quantities of purchasing power through the claims process. Again, this gives them the ability to set environmental standards for such goods and services in the purchasing chain.

References

Global Commons Institute Web Site ("Contraction and Convergence") (www.gci/org.uk).

Harvey, R. (2002) The Debate on Global Warming, in *The Geneva Papers on Risk and Insurance – Issues and Practice*, 27:1 (January 2002), pp. 78-88.

Intergovernmental Panel on Climate Change (IPCC) *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Cambridge University Press for Intergovernmental Panel on Climate Change Working Group II, 2001.

UNEP Finance Initiatives (UNEP FI) (2002) *Climate Change and the Financial Services Industry*, Module 1 (Threats and Opportunities) and Module 2 (A Blueprint for Action), UNEP, Geneva.

UNEP Finance Initiatives (UNEP FI) (2002) *Industry as a Partner for Sustainable Development, Finance and Insurance*, UNEP, Geneva. ◆

Bioremediation, phytotechnology and artificial groundwater recharge: potential applications and technology transfer issues for developing countries

Goen Ho, Professor, Environmental Technology Centre, Murdoch University, Perth, Western Australia 6153 (g.ho@murdoch.edu.au)

Summary

Bioremediation, phytotechnology and artificial groundwater recharge have proven effective in industrialized countries. They also have great potential for use in the developing world. Mimicking naturally occurring processes, they provide solutions that are environmentally sustainable. When these and other technologies are applied in developing countries, social, economic and environmental conditions need to be taken into account at the local level. Issues related to technology transfer and capacity building should also be adequately addressed.

Résumé

Si la biodépollution, les phytotechnologies et la recharge artificielle des nappes phréatiques ont montré leur efficacité dans le monde industrialisé, elles offrent aussi des possibilités considérables dans les pays en développement. Imitant des processus naturels, elles apportent des solutions tout à fait viables du point de vue de l'environnement. Mais lorsqu'on applique ces technologies et d'autres dans des pays en développement, il faut tenir compte du contexte social, économique et environnemental local. Il faut aussi s'attaquer aux problèmes de transfert de technologie et de renforcement des capacités.

Resumen

En los países industrializados se ha demostrado la eficacia de la biorremediación, la fitotecnología y la recarga artificial de acuíferos. Estas tecnologías también tienen un gran potencial para ser aplicadas en los países en desarrollo; al imitar procesos naturales, brindan soluciones ambientalmente sostenibles. La aplicación de éstas y otras tecnologías en países en desarrollo exige la consideración de las condiciones locales en términos sociales, económicos y ambientales. Asimismo, es necesario revisar adecuadamente cuestiones relativas a la transferencia de tecnología y al fortalecimiento de capacidades.

We are all too aware of the statistics revealing the diminishing availability of good quality water and the increasing threat that this poses to the health and life of humans and other life forms on earth.[1] The evidence for this is obvious in cities in developing countries. The way we manage our water is unsustainable.

Figure 1 shows current practice, with waste water from industry, municipal waste water, stormwater and municipal solid waste being discharged into rivers and seas. The result is pollution of the receiving water, making it very poor quality for humans (water not fit for swimming or other contact recreation) and for the aquatic organisms on which we depend for our existence.

One way to deal with this situation involves collecting municipal solid waste and burying it (landfilling), and collecting waste water and stormwater in a sewerage system and treating the collected waste water. Solids (sludge) separated from the treatment of the waste water are landfilled or incinerated; or they may be applied in agriculture as biosolids (Figure 1), in which case nutrients (nitrogen and phosphorus) are returned to nature as fertilizers. But the sludge is usually contaminated by industrial waste (e.g. heavy metals such as cadmium and nickel). Furthermore additional nutrients are still required for agriculture, and these are obtained through manufacture of chemical fertilizers. Phosphate rock is mined, imported and processed into superphosphate. Nitrogenous fertilizers are manufactured from atmospheric nitrogen.

These activities require significant amounts of energy, with corresponding impacts on the environment. Note that the flow of materials (e.g. phosphorus and nitrogen) is one-way: towards the receiving environment, polluting it. Note also that pollution of water is a result of materials that are not originally in the water, but transported with it. Water is the conveying agent for pollution of the receiving water environments.

Technology exists to treat the waste water to remove pollutants down to very low levels. This approach is costly and the pollutants invariably end up with the sludge. **Figure 2** shows a better way to manage the water cycle.

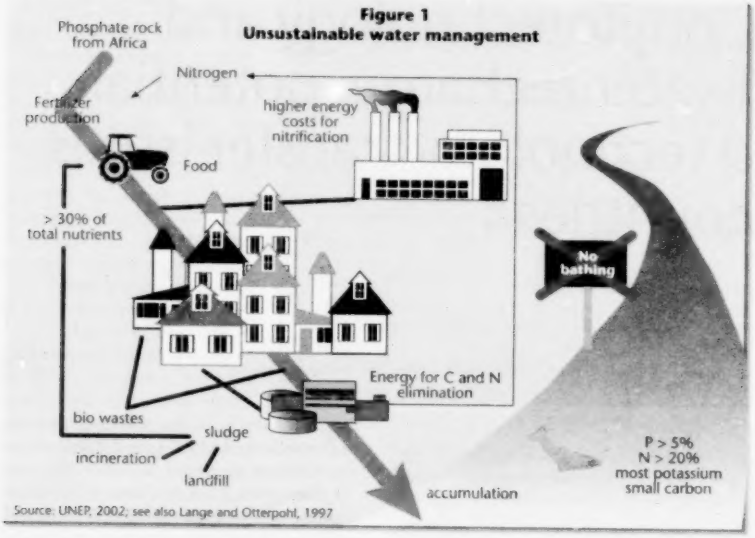
In this approach industrial waste is treated separately from municipal waste, thus preventing contamination of municipal waste by industrial waste (upper right hand corner of figure). Industrial waste should be reused and recycled in accordance with the waste management hierarchy: first, avoid producing waste; second, minimize what cannot be avoided; third, recycle/reuse what waste is unavoidable; and, finally, treat any remaining residue for safe disposal. Cleaner production techniques should be explored to assist in putting the waste management hierarchy into effect.

Stormwater should be separately collected and treated because it is likely to be less polluted. In the example shown in Figure 2 stormwater infiltrates into the ground and is a means of recharging aquifers. This is feasible where the soil is permeable. As the water infiltrates through the ground, large particulates are removed and bacterial action degrades them. There are other ways to manage the collected stormwater, such as the use of wetlands and ponds, which can also provide amenities for recreational purposes.[2]

Municipal solid waste should be collected and managed separately. Techniques are available to recycle aluminium, ferrous metals, plastic, glass and paper. The organic fraction of municipal solid waste should ideally be composted and the compost applied in agriculture. This will return organic carbon to the soil along with the fertilizer value of organic waste (nitrogen and phosphorus).[3]

Municipal waste water consists of grey water and black water. Grey water is water from bathing and washing, whereas black water is water from the toilet. The latter contains much of the fertilizer value in municipal waste water, but also human pathogens. In the example shown in Figure 2, grey water is treated using wetlands while black water is subjected to digestion treatment to produce biogas (a mixture of methane, CH_4, and carbon dioxide, CO_2), which is a source of energy. The solids left after digestion are applied in agriculture, again returning to the environment the fertilizer value of the waste by using it to produce food, which in turn is a major source of the nitrogen and phos-

Figure 1
Unsustainable water management



Source: UNEP, 2002; see also Lange and Otterpohl, 1997

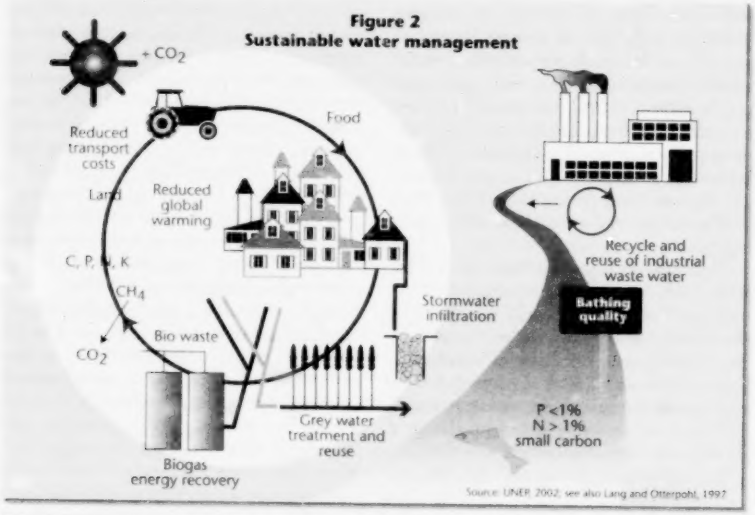
phorus in municipal waste water. We thus close the nitrogen and phosphorus loops and prevent contamination of our waters. The result is good water quality in our environment for humans and aquatic organisms.

The ideal picture shown in Figure 2 will take time to achieve in industrialized countries, which have adopted a management approach along the lines shown in Figure 1, with infrastructure such as sewerage and treatment plants that have a fairly long lifetime. Developing countries, however, can adopt the more sustainable management systems shown in Figure 2 without having to go through the high water and energy use stage shown in Figure 1.

The main message relating to sustainable development of industry is to manage waste separately from municipal systems and adopt the waste management hierarchy and cleaner production techniques, the aim being ultimately to achieve clean production with zero waste and close the cycles of all materials. By using this approach we don't have to solve problems, we avoid generating them in the first place.

In the meantime, though, we must deal with the numerous sites in developed and developing countries that have been contaminated by pollutants, and with groundwater reservoirs depleted by extraction rates that exceed natural recharge. Much progress and knowledge have resulted from remediating polluted sites and restoring the water balance of aquifers. This article discusses three techniques that can have wide applications in developing countries because they rely on processes that mimic those occurring in nature. These are bioremediation, phytotechnology and artificial groundwater recharge. The technology transfer issues that need to be addressed for adoption of these techniques in developing countries are also discussed.

Figure 2
Sustainable water management



Source: UNEP, 2002; see also Lang and Otterpohl, 1997

Bioremediation

Natural processes in the environment recycle materials in such a way that there is a dynamic equilibrium which maintains life on earth. An example is the carbon cycle (**Figure 3**). Carbon dioxide in the atmosphere is taken up by terrestial and aquatic plants for photosynthesis. Photosynthesis produces the building blocks of plant materials, which are a source of food for animals. Plant and animal excretion, litter, and dead plants and animals are decomposed by a host of microorganisms, returning the carbon to the atmosphere; or they accumulate over very long periods as peat, coal or oil.

Decomposition of organic materials also releases other elements such as nitrogen, phosphorus and sulphur, which are made available to plant roots and become part of other natural cycles (e.g. the nitrogen cycle, phosphorus cycle and sulphur cycle). We should note that in a pristine natural environment, such as an undisturbed forest, the water quality of streams and groundwater is very good. To a large extent this is because of the activity of microorganisms.

Naturally occurring microorganisms (bacteria, fungi, protists) breaking down organic materials, and active in the natural carbon and other cycles, can also break down contamination by substances such as sewage, crude oil, petrol from leaking storage tanks, kerosene, jet fuel, nitrogen from fertilizer, and even small quantities of toxic chemicals such as chlorinated solvents used in heavy industry, pesticides used in agriculture, and creosote used in preserving wood. For specific examples, case studies and further information, refer to the bioremediation site suggested in the References.

Using naturally occurring microorganisms is a great advantage because they are available freely. At contaminated sites, however, conditions are generally not favourable for these microorganisms. Compost may have to be added, for example, to provide the organic carbon required by the microorganisms. In other cases nitrogen, phosphorus and other nutrients may be required to provide more balanced "diet" for the microorganisms. Sometimes air is required to provide them with oxygen, and surfactant may need to be added to emulsify the soil to increase surface area availability. These measures add costs to the use of bioremediation. Enhanced bioremediation, which utilizes microorganisms that have been developed or selected for particular types of organic action, can be costly as well.

We should also recognize the limitation of bioremediation. Microorganisms cannot survive in high concentrations of toxic chemicals or salt; nor can they destroy heavy metals. In these cases chemical and other methods should be considered.

Phytotechnology

The use of plants to improve environmental quality is widely known and accepted, and can be more widely applied in developing countries. Plants can be used for:

- landscaping industrial sites to provide amenities for employees, visual barriers and buffer zones

from residential areas, as well as for water reuse;
- rehabilitation of areas affected by soil erosion;
- restoration of mined areas (e.g. surface mining);
- treatment of stormwater;
- treatment of waste water.

In many cases the plants so used can be harvested to produce timber, bio-energy and animal feed, or in wider or longer-term applications, e.g. reforestation to increase the sink for the greenhouse gas CO_2.

The term phytotechnology refers generally to the application of science and engineering to examine problems and provide solutions involving plants.[4] While there are many applications of plants, as indicated above,[5] the focus here is on the use of plants for pollution control, and in particular for the treatment of industrial waste that is organic in nature (e.g. abattoir waste, food processing waste). It should be emphasized, however, that treatment of waste is one of the lower rungs of the waste management hierarchy, and that first every attempt should be made to avoid, minimize, reuse and recycle. There are many opportunities to carry these out in industries generating organic waste.

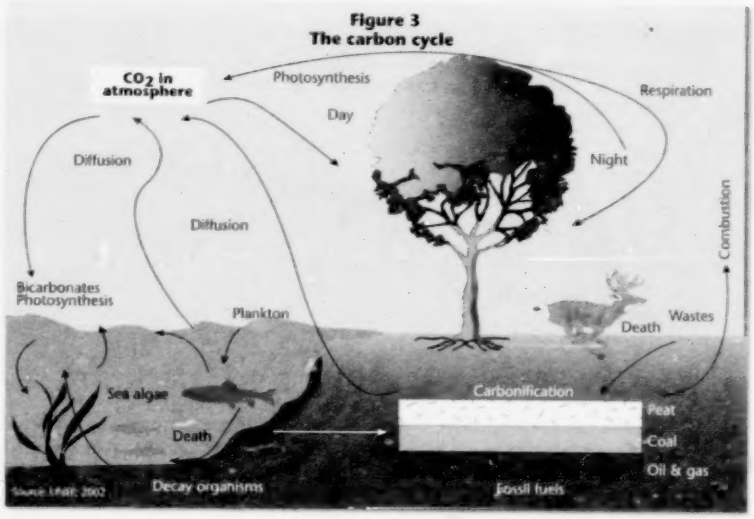
An outstanding example of a phytotechnology that can have wide application in developing countries is the use of wetlands (**Figure 4**). The wetlands can be existing ones carefully selected as suitable for the purpose, or (more commonly) constructed wetlands. Artificial wetlands are built by digging a hole, lining it with an impermeable barrier (such as high-density polyethylene plastic sheets) to prevent water from percolating through the soil, and laying gravel in it as a medium for plant roots. Suitable wetland plants (fast-growing, tolerant to high nutrients), preferably ones indigenous to the area, are then planted in the gravel.

As waste water is passed through the wetland biological purification takes place very much as in the case of bioremediation. Much of the degradation of the organic pollutants in the waste is due to the activities of microorganisms. Plants aid in providing oxygen to the root zone, in taking up nutrients and in immobilizing a number of pollutants (e.g. heavy metals) by uptake. This technology is appropriately called phytoremediation. To reduce the potential for mosquito breeding, the level of water in the wetland should be maintained below the surface so that there is no water ponding.

Another example of phytotechnology is soil filtration (**Figure 5**). Here waste water is allowed to filter through the soil in a slightly inclined field. As the water percolates through the soil, purification by natural soil microorganisms takes place. Plants (usually grasses) also take up nutrients. Thus the purification process is similar to that taking place in a constructed wetland.

An additional benefit of soil filtration is that the grass can be grazed by sheep, goats and cattle. It is important that toxic chemicals such as heavy metals not be introduced, so application is limited to waste water from industry which does not generate toxic materials. There is, however, still a wide potential application for waste water from abattoirs and food processing as long as it is not mixed with other industrial waste water. The only factor that then needs addressing is the risk of pathogen transmission.

Figure 3
The carbon cycle



A key to the success of the application of phytotechnology, phytoremediation, bioremediation and indeed any technology is the correct design, construction, operation and maintenance of the technology. With correct implementation, possible risk, including from the transmission of pathogens, is minimized or reduced to very low levels. On the other hand, incorrect implementation may result in undertreatment and risks of disease transmission.

Artificial groundwater recharge

Groundwater is normally recharged by rainfall (either recent or from more distant areas and times). It should only be withdrawn below the rate of recharge, so that the resource is used sustainably. In many parts of the world groundwater is now used far above the level of sustainability. This has resulted in the lowering of the water table. Wells have to be deepened to mine the water. As a result, in coastal areas there has been encroachment of salt water, making the groundwater unsuitable for use. In some areas lowering of the water table has resulted in uneven ground subsidence and damage to infrastructure (roads, buildings).

Artificial groundwater recharge is the augmentation of natural recharge. Sources of water can be stormwater (Figure 2), grey water and treated waste water. Recharge can be through a well drilled to the groundwater aquifer, or through recharge basins. The former requires water of a higher purity to prevent clogging of the recharge wells. The latter may have wider application in developing countries.

Figure 6 shows a schematic diagram of groundwater recharge using treated waste water. The treated waste water is introduced into unlined basins, allowing the water to percolate through the soils to the groundwater aquifer. During percolation, microorganisms degrade and transform organic substances in the water in the same way as in a bioremediation process. The use of multiple basins is essential, as the bottom of the basins become clogged with time and a rejuvenation period is required during which water is diverted to rejuvenated basins. In the drying period the organic and bacterial mat is dried by the sun, allowing regeneration of the infiltration rate.

Clearly artificial groundwater recharge can only

Figure 4
Wetland waste water treatment: a phytotechnology with wide potential for application in developing countries

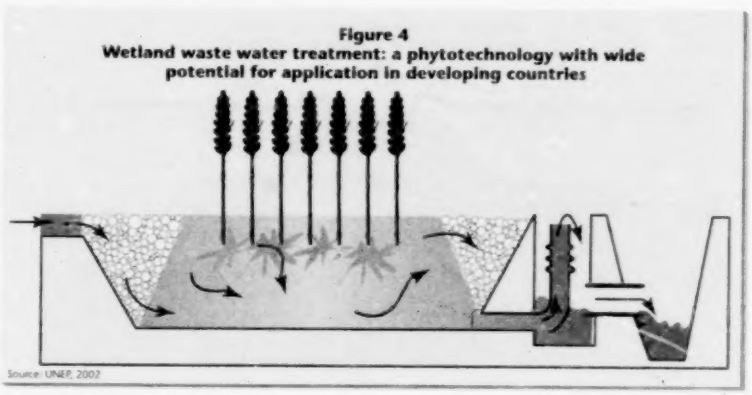
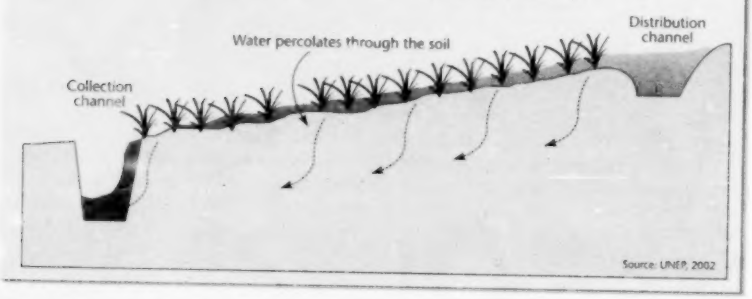


Figure 5
Soil filtration of waste water: another phytotechnology with wide application in developing countries



be used in areas where the soil and geological conditions are appropriate (unconfined aquifer, sufficiently permeable soils and underlying formation). Fortunately these are the same conditions that often give rise to excessive groundwater withdrawal, because of ease of access to the water.

Technology transfer issues

Bioremediation, phytotechnology and artificial groundwater recharge are examples of technologies that would be appropriate for developing countries because they rely on (and indeed mimic) natural processes. The capital and operating costs of these technologies can expected to be lower than purely engineered systems. On the other hand, these technologies require land area.

Beyond the conventional consideration of the technology itself and the costs (or economics) of implementing the technology, there are broader issues pertaining to the context of applying technologies in the local social, environmental and cultural situation of specific developing communities. These issues include:

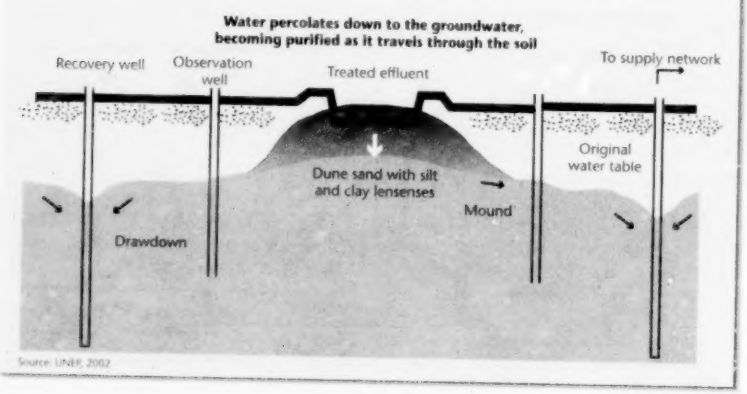
- providing quality information on technology, so that communities can make informed decisions;
- facilitating involvement of local community members in decision making, so that the technology selected fits in with the local social, environmental, economic and cultural conditions;
- building capacity on the part of decision makers in central, regional and local governments, so that there is consistent policy, and support for local implementation of the most appropriate technology for the local community.

These are system considerations which go beyond technology to the interface between technology and society. The right choice of technology in the system context can lead to sustainable development, and the wrong choice can lead to unsustainable development. One response to the challenge posed by this issue is provided by UNEP's International Environmental Technology Centre.[6] It has developed:

- a technology database containing information on technology, information systems/sources and institutions;
- tools for assessing the soundness of environmental technology, including criteria that should be employed;
- training modules in many areas of technology, including electronic-based training modules, to supplement face-to-face training;
- partnerships in information delivery and capacity building.

The effectiveness of any of these means, individually and in concert, should be continually assessed. A process of evaluation has commenced. In due course it will become clearer how the issues in technology transfer, and hence choice of technology, can be addressed.

Figure 6
Artificial groundwater recharge with treated waste water



Conclusions

Bioremediation, phytotechnology and artificial groundwater recharge have been shown to be effective technologies in industrialized countries and can have wide application in developing countries. These technologies mimic natural processes of purification and fit in with the concept of environmental sustainability discussed at the beginning of this article.

The application of these and other technologies in developing countries will need to consider specific local social, economic and environmental conditions. Tools have been developed to assist with carrying out this process systematically. Clearly there is a need to transfer this knowledge to decision makers and to build local capacity, and we need to strive harder to meet this need.

Notes

1. UNEP IETC (2003) *Sustainable freshwater management, information technology and technology transfer*, UNEP International Environmental Technology Centre (IETC), Osaka (www.unep.or.jp/ietc/focus_on_ietc/index.asp#1206).
2. UNEP (2002) Environmentally Sound Technologies for Wastewater and Stormwater Management – An International Source Book, International Water Association Publishing and UNEP IETC, London and Osaka (www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/main_index.asp).
3. UNEP (1996) *International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management*, UNEP International Environmental Technology Centre, Osaka (www.unep.or.jp/ietc/ESTdir/Pub/MSW/index.asp).
4. UNEP IETC (2003) *Phytotechnologies – A technical approach in environmental management*, UNEP International Environmental Technology Centre (IETC), Osaka (www.unep.or.jp/ietc/Publications/Freshwater/FMS7/1.asp).
5. Ibid. Also see related publications listed in this reference.
6. UNEP IETC, *Sustainable freshwater management.*

The Environmental Technology Centre is a Centre of Excellence in industry-focused research and development. It is a UNEP International Environmental Technology Centre Cooperation Centre. See www.etc.murdoch.edu.au.

References

In addition to the publications cited above, see J. Lange and R. Otterpohl, *Oekologie Aktuell Abwasser Handbuch zu einer zukunftsfaehigen Wasserwirtschaft*, Mallbeton GmbH, Donaueschingen-Pfohren, 1997.

A useful start for finding resources on bioremediation is www.enviroliteracy.org/article.php/625.html and the links contained therein.

For information on artificial groundwater recharge, see www.iah.org/recharge/links.html.

Water scarcity, desalination and pollution

Walid A. Abderrahman, Professor, Water Resources Management, Manager, Water Section, Research Institute, King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia (awalid@kfupm.edu.sa)
Tahir Husain, Professor, Environmental Engineering, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, NF, Canada A1B 3X5 (thusain@engr.mun.ca)

Water shortages, exacerbated by rapid population growth, urbanization and higher living standards worldwide, have led many countries (especially in arid and semi-arid regions) to adopt desalination technologies, above all to meet household demand. The desalination industry became commercial in the 1950s and 1960s. With major decreases in costs and increases in efficiency, particularly since the 1970s, desalination has become a strategic and dependable source for meeting household needs.

Today there are over 13,600 desalination plants of various types in over 120 countries in the Middle Eastern, European and Mediterranean regions, as well as in North America and the Caribbean. World desalination capacity is about 9.6 billion cubic metres (BCM). About 47% of the total is in Gulf Cooperation Council (GCC) states (Saudi Arabia, Kuwait, United Arab Emirates, Bahrain, Qatar and Oman).[1]

Desalination plants release gases, hot brine, treatment chemicals and trace elements, which contribute to the pollution of the surrounding environment. The observed negative impacts of desalination on health and the environment have so far been limited. However, with desalination capacity expected to increase over the long term, the potential effects of such plants in both coastal zones and inland areas cannot be ignored.

Domestic water supplies and desalinated water production

The GCC states provide a good example of how rapid urbanization and population growth are leading to substantial increases in household water demand. The area's high average population growth rate (over 3.4%) translated into a population increase from about 14 million in 1970 to nearly 30 million in 2000. Household water demand rose from 2.6 BCM to nearly 4 BCM between 1990 and 2000. It is expected to reach 10.4 BCM by 2030.

For more than 30 years the GCC countries have been building desalination plants and expanding existing ones to meet growing demand. The six states now have 36 large seawater and brackish water desalination plants: 21 on the coast of the Red Sea and 15 on the Gulf coast. The combined production capacity of desalination plants in the GCC countries increased from 1.5 BCM in 1990 to 2.7 BCM in 2000, as plants were added or expanded. Saudi Arabia, with production of just over 1 BCM in 2001, is the world's largest desalinated water producer.

Over 85% of the desalination plants in the GCC use multistage flash (MSF) systems. These systems, which are dual-purpose, are capable of producing both water and electricity. Most of the remaining plants are based on reverse osmosis (RO) technology, which uses membranes.

Both types of process require energy for steam, hot water and pumps. RO requires about 1.4-5.5 kWh per cubic metre, depending on the salinity of the water input. MSF plants require about 3.5-6 kWh per cubic metre to drive pumps and 16-32 kWh per cubic metre to heat water, depending on the design factor and performance ratio. Most MSF plants in the GCC are used to produce electricity as well as water. Annual electricity exports (i.e. energy generated above and beyond plant requirements) from MSF plants in Saudi Arabia totalled about 21.86 million MWh in 2000, or about 20% of all the electricity produced in the Kingdom.

The unit cost of seawater desalination in Saudi Arabia is about US$ 0.70 per cubic metre in the case of large dual-purpose MSF plants, if the energy used is assumed to be purchased at world prices. A more realistic seawater desalination cost, in the case of a medium-capacity plant also producing electricity, is about US$ 0.90 per cubic metre. The cost of water desalinated using RO and brackish water (rather than seawater) in GCC states ranges from about US$ 0.3 to 0.85 per cubic metre, depending on the salinity level of the feed water and the volume of water production. These costs do not take into account the additional energy required to pump the desalinated water to inland cities.

In 1978 the cost of desalination in Saudi Arabia was about US$ 3 per cubic metre. Further decreases can be expected with improvements in energy consumption, efficiency of operation, and membrane technologies.

Impacts of desalination plants

Effects of energy use on air quality

Many desalination plants use fuel oil, some use crude oil, and a few use natural gas. The sulphur content of the crude oil used is 2.9% by weight, while that of the fuel oil used is 1.7-3.7% by weight. The major primary pollutants emitted are sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and particulate matter (PM). Other emissions include volatile organic compounds (VOCs) and ozone.

The health effects of acute and repeated exposure to these air pollutants have been extensively reported. They include chronic respiratory disease and eye and throat irritation. High levels of SO_2 aggravate chronic illnesses such as asthma; doses of SO_2 as high as 5000 to 13,000 µg per cubic metre can cause severe malfunctioning of the lungs. Fine PM can cause increased mortality and asthmatic problems in children and the elderly and is a suspected carcinogen. High levels of ozone are harmful to humans and plants. Some of the constituents of VOCs are highly toxic and carcinogenic.

It has been estimated that the boilers of three large desalination plants use 3 million tonnes of number 6 fuel oil per year, and that annual stack emission rates from three such plants are 5161 tonnes of fine PM, 107,472 tonnes of SO_2 and 18,174 tonnes of NO_x. One study has shown that levels of SO_2 produced at a large desalination plant exceeded the permissible limits when power production reached about 3600 MW, which occurred for short periods every year.[2] Because of the expected long-term increase in power generation, it will be necessary to shift from oil to natural gas in order to lower emission levels enough to eliminate long-term health and environmental hazards. GCC countries have begun implementing fuel shifting plans accordingly.

Effects on the marine environment

Marine resources near a desalination plant are affected by increases in salinity, temperature, nutrients, and metals such as copper, nickel, iron, chromium and zinc.

Water temperatures near desalination plant outfalls have been measured at about 5-6°C above the ambient. In winter the rise in temperature promotes biological activity; significantly reduced biological activity has been observed in summer. A detailed simulation study, with appropriate hydrodynamic models, is needed to predict temperature increases and salinity levels.

The high salt concentration of the discharge water and fluctuations in salinity levels can kill organisms near outfalls. In addition, discharges from desalination plants are denser than seawater and can sink to the bottom, potentially harming benthic communities. These effects can be significantly reduced if desalination plant discharges are diluted with cooling water discharges (or discharges from sewage treatment plant) that are less dense than seawater.

The brine discharged from desalination plants carries small amounts of copper, nickel and manganese resulting from the corrosion of metals in tubes, water boxes and flash chambers. The metals concentrate in the upper few millimetres of the ocean (the micro layer) and can be toxic to fish eggs, plankton and larvae there. Other impacts, which need further study, involve the following:[3]

Continued page 40 ▸▸

Continued from page 39

- pre-chlorination of feed water at intake to prevent bio-fouling;
- oxygen levels below those of receiving waters from anti-corrosion chemicals;
- chemicals from pre-treatment of feed water, including biocides, SO_2, ferric chloride, polyelectrolytes and anti-sealants such as polyacrylic acid, antifoam agents and polymers;
- chemicals used in flushing pipes and cleaning the membranes in RO plants, including sodium compounds, hydrochloric acid, citric acid, alkaline polyphosphate, biocides, copper sulphate and acrolein;
- chemicals used to preserve RO membranes (e.g. propylene glycol, glycerine and sodium bisulphite);
- metals picked up by the brine in contact with plant components and pipelines.

Water intake facilities

Intake of water directly from the sea usually entails loss of marine organisms: they either collide with screens at intake point, or enter the plant with the feed water and are killed during plant processes. Some small organisms are damaged by passing through the screen and filters of the plants.

Disposal of brine from inland RO plants

Uncontrolled inland disposal of brine from RO plants located far from the coast seriously pollutes both shallow and deep aquifers. It also contributes significantly to shallow water table formation and rise within and around cities and industrial areas. This problem has been experienced in several inland urban and industrial areas where hundreds of RO plants are used to produce freshwater from brackish groundwater for drinking and industrial purposes. These problems could be eliminated through proper treatment of brine to minimize its volumes.

Measures to minimize environmental impact

With the expected large and long-term increase in desalination capacity worldwide, the potential long-term coastal zone impacts of desalination cannot be ignored. With proper planning, the negative impacts can be minimized by using natural gas as fuel and introducing buffer zones around plants. The numbers and lengths of expected expansion pipelines and power transmission lines should be minimized, and the size of new seawater intake and outfall structures should be reduced as much as possible. Chemicals with less impact should be substituted wherever possible to minimize hazards to marine ecosystems.

The introduction of multiport nozzles and the dilution of brine with cooling water will contribute effectively to eliminating the above impacts. To assess the environmental and human health impacts of desalination projects, a systematic step-by-step approach should be followed in conducting environmental impact assessments. This will help to minimize the impact and to identify mitigation measures. In the United States, for example, desalination projects must be constructed and operated within the regulations related to the Coastal Zone Management Act, the Clean Water Act and the National Environmental Policy Act.[4]

Conclusions

With advances in science and technology, desalination processes have been adopted by over 120 countries around the world to fill the gap between domestic water demands and supplies, especially in arid and semi-arid regions. The costs of desalination are expected to fall in the near future due to improvements with respect to operating efficiency, membrane technologies and energy consumption. The health and environmental impacts of desalination plants can be mitigated through proper planning and the use of a systematic approach in conducting environmental impact assessment.

Notes

1. Abderrahman, W. A. (2001) Energy and Water in Arid Developing Countries: Saudi Arabia, a case study, in *International Journal of Water Resources Development*, theme issue on water management in Saudi Arabia, Vol. 17, No. 2; Economic and Social Commission for Western Asia (ESCWA-UN) (2001), *The Role of Desalination Water in Augmentation of the Water Supply in Selected ESCWA Member Countries*, Distribution General E/ESCWA/ENR/2001/19, Beirut, Lebanon.
2. Husain T. (2001) Environmental Impact Assessment of Desalination and Treated Wastewater Reuse in the Middle East Countries, in *Proceedings of the First Arab Countries Conference on Economic and Social Uses of Water in Arab Countries*, organized by World Water Council (ARWATEX), 18-21 June 2001, Beirut, Lebanon.
3. California Coastal Commission (1993) *Seawater Desalination in California* (can be downloaded at www.coastal.ca.gov).
4. Ibid.

References

In addition to the publications cited above, see J. Lange and R. Otterpohl, *Oekologie Aktuell Abwasser Handbuch zu einer zukunftsfaehigen Wasserwirtschaft*, Mallbeton GmbH, Donaueschingen- Pfohren, 1997.

A useful start for finding resources on bioremediation is www.enviroliteracy.org/article.php/625. html and the links contained therein.

For information on artificial groundwater recharge see www.iah.org/recharge/links.html.

Towards a new form of urban sanitation and water infrastructure

Saburo Matsui, Kyoto University, Graduate School of Global Environmental Studies, Sakyo Kyoto 606-8501 Japan (matsui@eden.env.kyoto-u.ac.jp)

Summary

The technologies referred to collectively as "ecological sanitation" offer solutions to two key water issues: how to halve the proportion of people in the world who lack water supply and sanitation; and how to address eutrophication in lakes, reservoirs and enclosed seas. Nitrogen and phosphorus overloads come mainly from urban waste water and agricultural fertilizer runoff. Urine and faeces (especially urine) contain nitrogen and phosphorus. A new approach to managing human waste would make it possible to recycle these substances in agricultural areas.

Résumé

Les technologies regroupées sous l'appellation " installations sanitaires écologiques " offrent des solutions à deux problèmes majeurs : comment diviser par deux le nombre de gens dans le monde qui n'ont pas accès à l'eau potable et à des infrastructures d'assainissement ; comment remédier à l'eutrophisation des lacs, des réservoirs et des mers fermées. Les surcharges d'azote et de phosphore proviennent principalement des eaux usées urbaines et du ruissellement des engrais agricoles. L'urine et les matières fécales (surtout l'urine) contiennent de l'azote et du phosphore. Une nouvelle approche de la gestion des déchets humains permettrait de recycler ces substances dans les régions agricoles.

Resumen

Las tecnologías agrupadas bajo el concepto "servicios sanitarios ecológicos" ofrecen soluciones para atender dos temas relativos al agua: cómo reducir a la mitad el porcentaje de la población mundial que carece de abastecimiento de agua y acceso a servicios sanitarios, y cómo atacar la eutroficación en lagos, reservas y mares cerrados. Las sobrecargas de nitrógeno y fósforo provienen principalmente de las aguas residuales urbanas y del escurrimiento de fertilizantes. La orina y la heces fecales contienen nitrógeno y fósforo (sobre todo la orina). El desarrollo de un nuevo enfoque para el manejo de los desechos humanos permitiría el reciclaje de estas sustancias en zonas agrícolas.

Delegates to the Johannesburg Summit in 2002 agreed a goal to expand access to sanitation. Over a billion people lack access to clean drinking water (a problem cited two years earlier in the Millennium Development Goals) and 2.4 billion do not have access to proper sanitation. Reaching the agreed goal of halving the proportion of people in the world who lack water supply and sanitation by 2015 will require global efforts. Environmental scientists must be involved in seeking the solutions.

The sanitation issue is closely tied to other issues, such as eutrophication of lakes and coastal zones (which is directly related to agricultural use of chemical fertilizer containing nitrogen and phosphorus). This article proposes new solutions to deal with fundamental issues of sustainable water management, sanitation and agriculture.

It is now accepted that source control is the best way to prevent contamination of water with pathogens and pollutants. Methods of isolating and treating such contaminants at source are often available and cost-effective. Meanwhile, as the costs of treating and transporting water increase, current approaches to water supply and waste water treatment are becoming unaffordable for developing countries.

In areas with chronic, serious water shortages, conventional sewer systems cannot be used, as they consume too much water. A large share of humanity faces such water shortages.[1] How to provide sanitation in such cases is a challenge for sanitary engineers. In these circumstances, the technologies known collectively as ecological sanitation – which not only save water but also recover valuable material from human wastes – may provide a solution.

The need for a paradigm shift

Global environmental issues often involve the water sector through questions related to water quantity and quality, as well as sustainable management of water infrastructure. A key issue is that many sewage treatment plants do not function well enough to protect receiving waters. It is becoming increasingly necessary to put more emphasis on pollution prevention and the recovery of mineral resources such as nitrogen and phosphorus from waste streams.

In general, the main water quality issues are:

- organic pollution, as measured by biochemical oxygen demand (BOD) and chemical oxygen demand (COD);
- eutrophication, the process by which organic material from plants accumulates and replaces oxygen in still or slow-moving surface waters (accelerated by nitrogen and phosphorus overloading);
- contamination by micropollutants such as endocrine disrupters and pharmaceuticals;
- new types of pathogenic organisms, such as *Escherichia coli* type O157 and *Cryptosporidium parvum*.

Developed countries must primarily deal with challenges regarding water economy, and related energy use for advanced treatment of drinking water and waste water, to meet growing demand for potable water. Developing countries, however, face difficulties with respect to all aspects of water management. The tendency has been for these countries to follow western approaches to water infrastructure development.

Industrialized societies have spent a century and a half building up such infrastructure, which includes sewerage based on single-pipe drainage from flush toilets and, in most developed countries, the flow of storm water into this same single-pipe drainage system, which transports all urban water to sewage treatment facilities.

Is this the only way to do it? Are there options that can help developing countries introduce urban water infrastructure and enable developed countries to improve their ageing existing infrastructures? We need a paradigm shift towards sustainable urban water infrastructure.

Eutrophication

Eutrophication is a serious problem in many lakes, reservoirs and enclosed seas. The role of nitrogen and phosphorus overloading in eutrophication is well-documented. This phenomenon entails excess algal growth, resulting in odours, cyanotoxins and massive growth of water hyacinth.

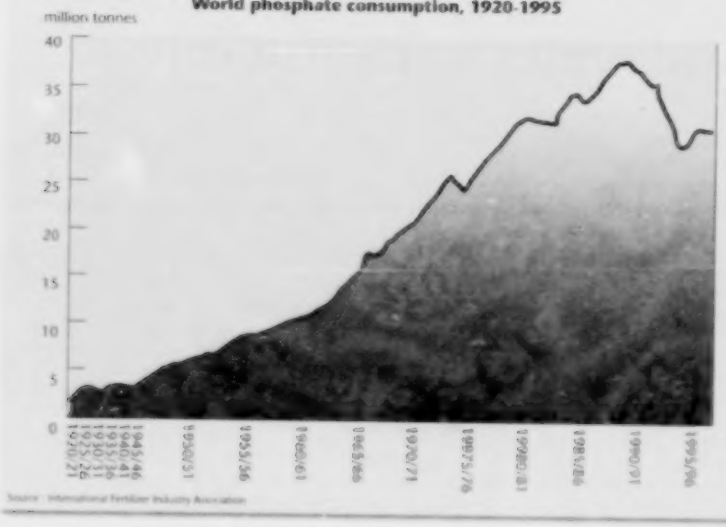
Nitrogen and phosphorus in soil are not pollutants. Increased use of nitrogen, phosphorus, pesticides and improved seeds from the 1960s led to the rise in food production that was called the "green revolution". Unfortunately, it also led to large amounts of nitrogen and phosphorus being released from fields to surface water and groundwater. Excess amounts of these substances in water do constitute pollution. Agricultural runoff from Japanese paddy fields, for example, contains about

10-20 mg of nitrogen and 1 mg of phosphorus per litre (by comparison, Japanese environmental standards limit the nitrogen and phosphorus content of lakes to 0.2 mg and 0.01 mg per litre, respectively). Clearly one basic way to reduce overloading would be to decrease the amount of nitrogen and phosphorus applied to fields.

(It should be noted that air pollutants such as nitrogen oxides also contribute to water pollution. Another issue only touched on in this article is nitrate contamination of groundwater.)

Nitrogen and phosphorus concentrations in sewage effluent in most developed countries are higher still, at 20 mg and 8 mg per litre, respectively. Phosphorus can be removed by advanced physico-chemical treatment, but nitrogen removal by current advanced sewage treatment technology is insufficient; after denitrification treatment the nitrogen content of effluent may still be as high as 8 mg/litre. Furthermore, industrial waste water requires especially costly measures because the balance of BOD and nitrogen is often not favourable for biological nitrogen removal. Advanced sewage treatment in general is expensive and may not be feasible in developing countries.

Figure 1
World phosphate consumption, 1920-1995



Source: International Fertilizer Industry Association

The agricultural context

One reason eutrophication must be halted is that it represents a massive waste of phosphorus, which is a limited resource. World fertilizer consumption has increased tenfold since 1930; between 1950 and 1995 alone, phosphate use grew almost sixfold, from about 5 million tonnes to 30 million tonnes, or an average of around 4% a year (Figure 1). The growth rate for global fertilizer consumption appears to have peaked, but current fertilizer industry forecasts of global phosphate use suggest that the growth rate will continue to be nearly 2.8% a year for the next several years before levelling off. Economically feasible phosphate reserves thus could start running out by the end of this century.

The author and many other scientists propose recycling of phosphorus from human excreta to agriculture. To recover phosphorus, as well as nitrogen and potassium, from human urine requires a type of sewerage that can divert urine into pipes separate from those delivering faeces and grey water. This kind of sewage works can also greatly reduce the amount of water used for flushing.

Conventional sewerage is not sustainable. For the 21st century we need new systems, including new institutions and technologies. For developing countries in particular, addressing the need for sanitation is a top priority. To be sustainable in developing countries, sanitation systems must save water, facilitate treatment and aim at recycling. Developed countries could also benefit from such systems.

Ecological sanitation

The First International Conference on Ecological Sanitation was held in Nanning, China, in November 2001. It defined ecological sanitation as "an approach ... which respects ecological integrity, conserves and protects freshwater, promotes dignified and healthy living, and recycles nutrients from human excreta for use in agriculture."

A complete ecological sanitation system for an urban area consists of:

- eco-toilets, processing chambers and containers for urine, at household level (all are above ground and they are often located upstairs);
- a collection service for urine (once or twice a week) and for desiccated, partly sanitized faeces (once or twice a year);
- an eco-station for secondary treatment of partly sanitized faeces, which usually involves high-temperature composting with other organic waste such as kitchen refuse;
- recycling of urine and compost in urban agriculture, energy forest plantations, parks, golf courses, wasteland development, etc.

Eco-toilets (Figures 2-4) are designed to keep urine and faeces, as well as water and faeces, separate. Squatting pans with urine diversion, made of fiberglass or plastic, are mass-produced in China and can be purchased for the equivalent of US$ 10. A similar model made of porcelain is also produced in China. Other types, including sitting-position models, are made in South Africa, Mexico and Sweden, among other places.[3] The widely used

Figure 2
Fiberglass seat riser with urine diversion, developed by a SanRes-funded project in Mexico in 1994

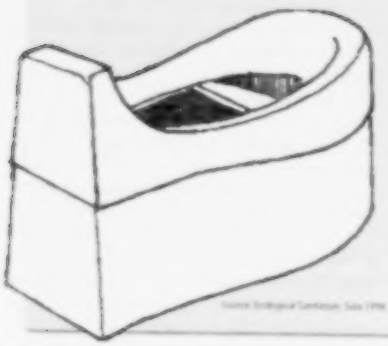


Figure 3
Porcelain squatting pan with urine diversion, developed by a SanRes-funded project in China in 1997 and now produced at a factory outside Beijing

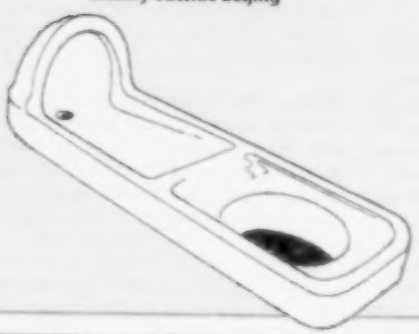


Figure 4
Water toilet providing urine and faeces diversion, made in Sweden

Table 1
Nutrient distribution between urine and faeces

Parameter	Urine		Faeces		Total discharge	
	g/person/day	%	g/person/day	%	g/person/day	%
Wet weight	900-1200	90	70-140	10	1000-1400	100
Dry weight	60*	63	35	37	95	100
Nitrogen	11.0	88	1.5	12	12.5	100
Phosphorus	1.0	67	0.5	33	1.5	100
Potassium	2.5	71	1.0	29	3.5	100

*A large proportion of this is rapidly biodegradable. Much of it degrades in sewer pipes.

Source: Based on data from Swedish Environment Protection Agency, 1995

Table 2
Pollution loads of waste water generated by one person

Item	Average g/person/d	Standard deviation	No. of Data	Urine + faeces	Grey water
				%	
BOD	58	18	99	32	68
COD mn*	26	9	96	36	64
SS**	44	16	96	47	53
Nitrogen	12.5	3	8	75	25
Phosphorus	1.5	0.2	8	75	25

*COD measured with potassium permanganate
**Suspended substances

Source: Modified from Guideline for Investigation of a Basic Area Sewage Work, Ministry of Construction, Japan, 1998

Swedish models include both two-compartment dry toilets and urine-faeces diversion water toilets.

In an eco-toilet, urine is piped into a covered container, kept temporarily on site, then transferred to a larger tank, treated and stored for use as fertilizer. Human urine, which contains most of the nutrients in human excreta (see below), is an excellent fertilizer.

The faeces drop straight into a chamber. Each user adds a small amount of dry material, preferably a high pH material such as wood ash or lime; if neither is available, dry husks, sawdust, peat moss or dry soil can be used. When the chamber is nearly full (normally after six to eight months) the eco-toilet is turned so that the faeces drop into a second chamber. When the second chamber is full, the first chamber is emptied and the toilet is turned again.

By this time the material from the first chamber is dry and odourless, or is slightly humid and smells like humus-rich soil. It is by no means sterile, but will not contain more pathogens than most topsoil. To achieve complete pathogen destruction, this dry material is transferred to a composting station or "eco-station" for secondary treatment such as high temperature composting.

To function properly, an ecological sanitation system must be backed up by awareness, information, training and follow-up. Participation by the prospective users is a prerequisite for success.

The concept "Don't mix!"[4] to describe separate collection and treatment of urine, faeces and grey water (from the bath, laundry and kitchen) opens up new possibilities for conventional sewage works. Existing sewerage and sewage treatment plants can be rebuilt for resource recovery to meet the tremendous challenge of redressing the deterioration of the global water environment.

Urine diversion

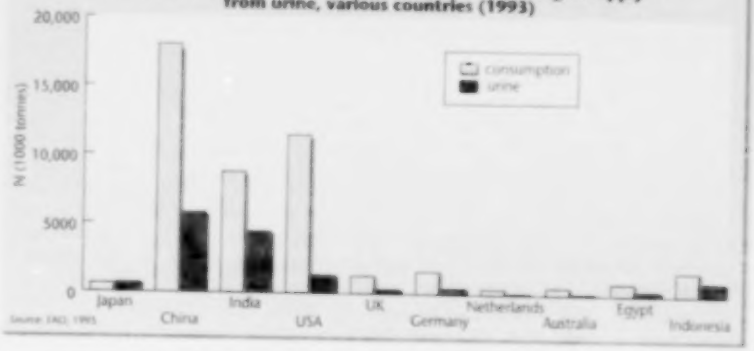
Diversion of urine at source could make a major difference, especially in urban areas, by drastically reducing water use for flushing and by improving the efficiency of biological nitrogen and phosphorus removal at sewage treatment plants. The process would involve laying a second set of pipes next to existing ones. From the initial underground storage tank, vacuum trucks would transfer urine to a processing plant for recovery of nitrogen, phosphorus and potassium and removal of salt. (This last process improves the quality of the effluent for agricultural use.) Unlike faeces, urine is generally free from pathogens.

Tables 1 and 2 show the nutrient distribution and pollution loads of human excreta and grey water. The latter contributes more BOD and COD than urine and faeces, but its nitrogen and phosphorus contents are lower. From the data in the tables we can determine that urine contains 66% of the nitrogen and 50.3% of the phosphorus excreted by people. Thus urine diversion at source can significantly help reduce the nutrient load to municipal waste water treatment plants.

From Table 2 we can calculate that the average sewage pollution load consists of BOD_5, nitrogen and phosphorus in the proportion of 100:19:2, whereas the ideal proportion for treatment by a conventional biological system is about 100:5:1. The excess of nitrogen and phosphorus is evident. By modifying conventional biological systems, waste water engineers have developed various types of biological denitrification processes that can remove about 80% of the nitrogen in the average sewage pollution load. This is seldom enough to control eutrophication. More nitrogen can be removed if the BOD load is increased, for example by adding food processing waste.

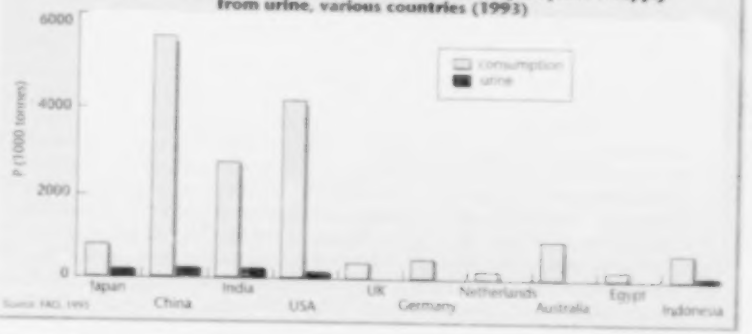
Similarly, waste water engineers and microbiologists have developed a biological phosphorus

Figure 5
Nitrogen fertilizer consumption and potential nitrogen supply from urine, various countries (1993)



Source: FAO, 1995

Figure 6
Phosphorous fertilizer consumption and potential phosphorus supply from urine, various countries (1993)



Source: FAO, 1995

removal process by modifying a conventional biological system to allow generation of phosphorus-rich sludge that is then removed from the water. The process system requires a high BOD to phosphorus ratio, which can be achieved by adding high-BOD industrial waste water to the sewage. Conditions permitting this rarely occur.

However, excluding urine from the sewage can change the proportion of BOD:N:P to 100:8.2:1, thus improving loading conditions and enhancing denitrification and phosphorus removal efficiency.

Urine recovery and nutrient recycling

Modern conventional agriculture requires chemical fertilizer. Recycling human excreta from urban areas to farm fields can meet some of these nutrient needs, especially as regards phosphorus – a particularly important point because of the limited availability of naturally occurring phosphorus, noted above.

Figures 5 and 6 show nitrogen and phosphorus consumption in various countries and potential supply rates of urine nutrients. Nutrient recovery from urine is in general not enough for agricultural use in any country except Japan (nitrogen only). Urine recovery could provide enough nitrogen for the Japanese agriculture sector if half the food consumed in that country were imported, as is now the case.

The World Water Vision of 2000 predicts that water use in agriculture will increase by only 9% between 1995 and 2025 (from an annual 1750 km^3 to 1900 km^3) while the human population will increase by 36% from 5.5 billion to 7.5 billion. Part of the difference in these two growth figures is expected to be water conservation in agriculture, which would likely translate into higher nutrient concentrations in agricultural runoff. Eutrophication of surface water and nitrate contamination of groundwater would therefore intensify under "business as usual" water management. Hence the necessity and the potential benefits of recovering nutrients from diverted human urine.

The Japanese case

Until the mid-20th century, Japan had sanitation systems that resulted in complete recovery of human excreta for agriculture. When chemical fertilizers became available, farmers abandoned the practice of collecting human waste from urban areas and municipalities had to take over the task.

Fifty years ago sewerage networks covered only parts of Tokyo, Osaka, Kyoto, Nagoya and a few other urban areas. To make up the shortfall, Japan developed a sophisticated night soil collection and treatment technology using biological nitrogen removal and chemical phosphorus removal. In 2002 there were 1187 night soil treatment facilities in Japan, serving about 30% of the population (or about 36 million people), treating urine and faeces

Multiple benefits through integrated end-use water management strategies

Robert C. Wilkinson, Lecturer, Bren School of Environmental Science and Management and Environmental Studies Program, University of California, Santa Barbara, Senior Fellow, Rocky Mountain Institute, 1428 West Valerio Street, Santa Barbara, California 93101, USA (wilkinson@es.ucsb.edu)

Around the world, urban and agricultural water use has long been facilitated by diversion of surface water and extraction of groundwater delivered through conveyance systems. Water is often transported over long distances to the place where it is ultimately used. As technological capacity developed over the past century, surface water diversions, groundwater extraction and conveyance systems increased in volume and geographical extent. Inter-basin transfers supplemented the water available within natural hydrological basins or watersheds. Agricultural and urban uses of arid lands were vastly extended by imported water.

The focus of technology development and policy for much of the past century was on the supply side of the water equation; that is, the emphasis was on extracting, storing and conveying water from natural systems to urban and agricultural users. Water policy has generally been designed to facilitate the development and use of these supply-side technologies. In the last quarter century, however, technological innovation has increasingly been applied to improving the efficiency of use of water resources. From pumps to plumbing fixtures and from industrial processes to irrigation systems, technology has vastly improved end-use efficiency.

This discussion focuses on the *multiple benefits available* from end-use efficiency strategies. Of particular importance is the potential for integrated water management strategies to provide significant energy savings. Examples from current applications in California will be used as a basis for assessing the opportunity to achieve multiple benefits.

Tapping the water-energy links

Water and energy systems are interconnected in key ways. Water provides energy (through hydropower) and water systems consume energy, primarily for pumping. Critical elements of typical water infrastructure are highly energy intensive. Extracting "raw" water from natural sources, moving large quantities of water long distances and over significant elevation gains, treating and distributing water within communities, using water for various purposes and treating the resulting waste water account for a major part of electricity and other energy use in many areas.[1]

The total energy embodied in a unit of water used in a particular place (i.e. the amount of energy required to transport, treat and process it) varies with location, source and use. Energy intensity will likely increase because of limited water resources and increasing regulatory requirements for water quality.

Improving water use efficiency (i.e. the useful work or service provided by a given amount of water) presents an important opportunity to reduce related energy requirements. Significant potential economic and environmental benefits can be achieved cost-effectively through efficiency improvements in water systems.

Water's energy intensity (i.e. the total amount of energy, calculated on a whole-system basis, required for the use of a given amount of water in a specific location) varies considerably by the location of end-users and sources. Water use in certain places is highly energy intensive, due to the combined requirements of conveyance over long distances and elevation lifts, treatment and distribution, and waste water collection and treatment. Work by various government agencies, professional associations, private sector users and NGOs has demonstrated the potential of combined end-use efficiency strategies: significant, profitable energy efficiency gains are possible through cost-effective water efficiency improvements.

The multiple benefits concept

When we analyze the costs and benefits of a proposed policy or action, we typically focus on accounting for costs. Then we compare those costs with a specific, well-defined benefit, such as additional increment of water supply. We often fail to account for other important benefits that accrue from well-planned investment. By focusing on multiple benefits, we account for various goals achieved through a single investment. For example, improvements in water use efficiency – meeting the same end-use needs with less water – also typically result in reduced energy use for pumping and treatment (with reduced pollution related to energy production as a result), reduced waste water capacity and processing requirements, and reduced extraction of source water from surface or groundwater systems (with fewer associated impacts). When water managers implement water efficiency strategies, they often do not receive credit for providing multiple benefits. From an investment perspective, and from the standpoint of public policy, the multiple benefits of efficiency improvements should be fully included in cost-benefit analysis.

combined. Dozens of these facilities have introduced membrane separation technology in biological treatment. Many have installed ozone treatment for colour removal, disinfection and deodorizing. Much of the treated sludge is used in agriculture.

If Japan were to introduce urine diversion and collection, nutrient recovery from urine would become more efficient. Collected faeces could easily be fermented to produce methane, and the residue would be excellent organic fertilizer. This approach would greatly help improve sanitation, agricultural fertilizer supply and the prevention of water pollution, including eutrophication. A modified Japanese process and technology would also be easy to transfer to developing countries, where sanitation infrastructure is urgently needed.

Conclusion

Conventional sewerage with modern treatment facilities is no alternative for poor communities or areas with water shortages. We need to reconsider present approaches and develop sustainable sanitation systems based on sound ecological principles. Urban areas with existing sewerage could consider installing dual pipelines in which one pipe carries urine plus a small amount of flush water to a storage tank for later collection by vacuum trucks, while the other carries faeces and grey water to sewage treatment plants. We might even envisage a triple system with separate pipes and treatment facilities for black, yellow and grey water. Urine diversion could also have a further benefit: urine processing can eliminate salt from effluent, reducing salt buildup in agricultural soil.

Notes

1. Population Action International, drawing upon the 1998 UN Medium Population Projections, estimates that by 2025 over 2.8 billion people in 48 countries will face water stress or scarcity.

2. Steen, I. (1998) Phosphorus availability in the 21st century management of a non-renewable resource (www.nhm.ac.uk/mineralogy/phos/p&k217/steen.htm).

3. Black, M. (2002) Conference report, First International Conference on Ecological Sanitation, 5-8 November 2001, published by WKAB, Stockholm; Esrey, S., J. Gough, D. Rapaport, R. Sawyer, M. Simpson-Hebert, J. Vargas and U. Winblad (1998) *Ecological sanitation*, Sida, Stockholm. The SanRes Programme has supported ecological sanitation projects in El Salvador, Mexico, Bolivia, South Africa, Uganda, Viet Nam and China. See www.ecosanres.org.

4. Winblad, U. (1998) Towards an Ecological Approach to Sanitation (keynote paper, International Toilet Symposium, Toyama, Japan, 1996), in M. Simpson-Hebert (ed.), *Sanitation promotion*, WHO, Geneva (WHO/EOS/98.5). ◆

Summary of urban best management practices (BMPs) in California

- Interior and exterior water audits and incentive programmes for single-family residential, multi-family residential and government/ institutional customers
- Plumbing, new and retrofit
- Enforcement of water-conserving plumbing fixture standards, including requirement for ultra-low flush (ULF) toilets in all new construction since 1 January 1992
- Support of state and federal legislation prohibiting sale of toilets using over 1.6 gallons per flush
- Plumbing retrofit
- Distribution system water audits, leak detection and repair
- Metering with commodity rates for all new connections and retrofit of existing connections
- Large landscape water audits and incentives
- Landscape water conservation requirements for new and existing commercial, industrial, institutional, governmental and multi-family developments
- Public information
- School education
- Commercial and industrial water conservation
- New commercial and industrial water use review
- Conservation pricing
- Landscape water conservation for new and existing single-family homes
- Water waste prohibition
- Water conservation coordinator
- Financial incentives
- ULF toilet replacement

The principle energy elements in water systems are:
- primary water extraction and supply delivery (imported and local);
- treatment, distribution and pressurization within service areas;
- on-site water pumping, treatment and thermal inputs (heating and cooling);
- waste water collection and treatment.

Pumping requirements at each of these four stages are often energy intensive.

Role and limits of technology in water systems

Technology is applied to the tasks of:
- extracting and delivering water;
- delivering actual services provided by water, such as waste removal and cooling;
- treating water before and after it is used.

During the past century ever more extensive and sophisticated water impoundment and conveyance systems have been developed around the world, facilitated and managed by public and private entities. Today the main constraints on water extraction are not technology limitations; indeed, many supply sources are technically attainable but off-limits because of high costs, social values, laws and environmental impacts. The focus of technology development and policy is therefore increasingly on more efficient use and on water treatment. For example, waste water treatment for reuse has substantially improved.

Innovation and technology development in end-use water applications and water treatment have progressed rapidly in recent decades. Techniques and technologies – such as laser levelling of fields, drip irrigation systems, the design of toilets and shower heads, filter systems, industrial processes and treatment technology – have changed the demand side of the water equation. End-uses of water now require much less volume than in the past to provide equivalent or superior services. Stormwater capture for groundwater recharge, and other innovative water capture strategies, are also enhancing water supply reliability. Geographical information systems and field technologies allow for improved location of leaks in buried pipes.

The roles of policy and price signals

Impetus for technology development and innovation has been provided in part by price signals and public policy. As water becomes more expensive, technology has provided a wide range of options for expanding the utility value of given amounts of water. Broader application of these technologies and techniques will yield significant additional "new supplies." Public policy has also been developed to encourage best management practices by suppliers.

Efficiency improvements are now considered supply options to the extent that permanent improvements in the demand-side infrastructure provide reliable water for other uses, including urban *continued on page 46* ▸▸

continued from page 45 and agricultural uses and environmental flows. Technology is also being applied to the problems of water contamination.

Best management practices (BMPs) developed and implemented by California's urban water sector incorporate both technical and management elements. A detailed discussion of each measure, along with related information, may be found on the Web site of the California Urban Water Conservation Council (www.cuwcc.org).

Opportunities for efficiency improvements in water management

A number of sophisticated and effective techniques have been developed to increase the efficiency of water systems and end-uses. Important progress has been made in all water use sectors, and major opportunities exist for further improvement. This management approach embraces water efficiency improvements as an extension of supply. The Metropolitan Water District (MWD) of southern California argues that a gallon (3.8 litres) of water conserved is "a gallon of water that can be directed to another use."

MWD reported in 1998 that it and its member agencies had replaced around a million water-wasting toilets with ultra-low flush (ULF) models and distributed some 3 million low-flow shower heads. The utility estimated that these fixtures save more than 54 million cubic metres annually.

Water efficiency potential in households

Water efficiency potential in the residential sector is generally categorized into indoor and outdoor use. Efficiency improvements indoors may be achieved by changing plumbing fixtures such as shower heads, faucet (tap) aerators, toilets, washing machines, dishwashers and other appliances and repairing leaks. Outdoor changes generally involve a combination of irrigation systems and landscaping, along with leak repairs.

The potential for increased water use efficiency in the residential sector is estimated at one-third. Richard Pinkham, a water expert with the Rocky Mountain Institute, notes that the penetration of efficient fixtures and appliances into North American homes is still quite low (35% for shower heads, 15% for toilets and less than 3% for high-efficiency washing machines). The Pacific Institute recently completed a study indicating that water use throughout California's urban sector could be cost-effectively reduced by about one-third. Residential indoor use can become considerably more efficient using current fixture standards. Potential savings with off-the-shelf technologies that outperform current standards go even further.[2]

Water efficiency potential in the commercial, industrial and institutional sectors

While the potential to increase water use efficiency in households has received considerable attention, the potential in other urban sectors is at least as large. Recent work suggests that significant opportunities for efficiency improvements and cost savings exist in each of these sectors.

Water managers typically put urban water use in a broad category called municipal and industrial (M&I), which generally includes residential uses. An important subset of M&I is the *commercial, industrial and institutional (CII)* category. CII users accounts for about one-third of urban water use in California.

The water savings potential in the CII category is significant. Recent studies and empirical performance data in California indicate a savings potential ranging from 25% to over 80% through efficiency measures with payback times of less than three years.[3] Dow Chemical achieved a 95% reduction at plant in Pittsburgh, California. A study prepared for the City of Los Angeles found savings of over 50% reported during a drought, including 79% for a nickel-chromium plating company, 63% for a brewery and 56% for a glass company. A study for the MWD indicates savings potential ranging from 39% for paper and 52% for primary metals to 65% for oil refineries and 81% for waste water treatment facilities.

Within the overall CII category in southern California, 80% of the water is used by 20% of the customers. For policy makers and water managers seeking to facilitate and support efficiency improvements, this concentration greatly increases the prospects for targeted strategies to assist large users with efficiency programmes.

Water and waste water treatment

Most electricity use in water and waste water treatment plants is for pumping. Reducing flow volumes results in significant energy savings. Other energy management opportunities exist through improved pumping equipment and operational control systems. Examples include high-efficiency motors, adjustable-speed drives, efficient pumps, and effective instrumentation and controls. Significant reductions in energy use and cost through energy management are reported at existing facilities. In many applications, measures such as the installation of high-efficiency motors, adjustable-speed drives and fine-pore diffusers can be implemented with payback periods of three years or less.[4]

Examples of commercial, industrial and institutional (CII) water uses

Commercial: Motels, hotels, restaurants, office buildings and other commercial facilities

Industrial: Fabrication, processing, washing and cooling

Institutional: Includes indoor and outdoor uses at schools, colleges, universities, churches, hospitals and government facilities.

CII also includes such municipal water uses as water system management, firefighting, and landscape irrigation in public parks.

Notes

1. Wilkinson, Robert C. (2000) *Methodology For Analysis of The Energy Intensity of California's Water Systems, and an Assessment of Multiple Potential Benefits Through Integrated Water-Energy Efficiency Measures*, Exploratory Research Project, Ernest Orlando Lawrence Berkeley Laboratory, California Institute for Energy Efficiency.

2. Pinkham, Richard (2003) 21st Century Water Systems: Scenarios, Visions, and Drivers, in *Proceedings of the Workshop on Sustainable Urban Water Infrastructure: A Vision of the Future*, US Environmental Protection Agency (see www.rmi.org, the Rocky Mountain Institute Web site); Pacific Institute, *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, November (see www.pacinst.org).

3. For a detailed analysis, see Robert C. Wilkinson, Arlene Wong and Lisa Owens-Viani, An Overview of Water-Efficiency Potential in the CII Sector, and other studies, in Viani, Wong and Peter Gleick (eds.), *Sustainable Use of Water: California Success Stories*, Pacific Institute, 1999.

4. Burton, Franklin L. (1996) *Water and Wastewater Industries: Characteristics and Energy Management Opportunities* (Burton Engineering), Los Altos, California, Report CR-106941, Electric Power Research Institute Report.

World News

State of the World 2004 on the price of consumption

With over a quarter of humanity now in the "consumer class," the unsustainable pace at which the world is consuming goods and services will have serious consequences for the well-being of people and of the planet, says the Worldwatch Institute in its annual report, *State of the World 2004*.

Around 1.7 billion people have adopted diets, transport modes and lifestyles that were once limited to the rich countries of Europe and North America and to Japan. In China alone, where 240 million people have joined the consumer class, this class will soon surpass that in the United States in size.

"Rising consumption has helped meet basic needs and create jobs," Worldwatch Institute President Christopher Flavin said in launching the report. "But as we enter a new century, this unprecedented consumer appetite is undermining the natural systems we all depend on, and making it even harder for the world's poor to meet their basic needs." He cited "higher levels of obesity and personal debt, chronic time shortages and a degraded environment" as "signs that excessive consumption is diminishing the quality of life for many people."

Spending on goods and services by households quadrupled between 1960 and 2000, to reach more than US$ 20 trillion. The 12% of the world's population living in North America and Western Europe accounts for 60%, while the one-third or so in South Asia and Sub-Saharan Africa account for 3.2%.

In the United States, the report says, most people have more than enough goods and services. There are more private vehicles than there are people licensed to drive. The average size of household refrigerators grew by 10% between 1972 and 2001, and the number of refrigerators per household rose as well. New houses were 38% larger in 2000 than in 1975, even though average household size dropped. It is largely because of these consumption patterns that the US, with 4.5% of the world's population, releases 25% of global CO_2 emissions.

Yet only about a third of Americans report that they are "very happy" – the same share as in 1957, when Americans were only half as wealthy. Meanwhile, to finance their consumption, Americans work nine more weeks a year than Europeans, on average.

Rising global consumption has a heavy price. Forests, wetlands and other natural areas continue to shrink. Over 90% of paper still comes from trees, accounting for about one-fifth of the total wood harvest worldwide. Some 75% of global fish stocks are exploited at or beyond sustainable limits. Transport is responsible for nearly 30% of world energy use and 95% of global oil consumption.

State of the World 2004 draws attention to a range of opportunities available to governments, businesses and consumers to curb and redirect consumption, including environmental tax reform, product take-back laws, product durability improvement, and promotion of personal responsibility at grassroots level.

For more information, see: www.worldwatch.org/pubs/sow/2004. ◆

Information technology summit, part 1

The first phase of the World Summit on the Information Society, held in Geneva in December, was attended by representatives of 176 countries, including 11 heads and deputy heads of state and government and 83 ministers or deputy ministers. They endorsed a Declaration of Principles that sets out a vision of an information society's values, and a Plan of Action outlining how to build on that vision and bring the benefits of information and communication technology (ICT) to underserved economies.

The three-day summit was the first multi-stakeholder activity at global level intended to shape the use of ICT for a better world. It brought together leaders, policy makers, ICT business people, voluntary and non-governmental organizations and top experts. In addition to plenary meetings and high-level roundtables, there were nearly 300 side events. The second phase of the summit, in Tunis in 2005, will measure progress on the goals set in Geneva and develop further actions.

United Nations Secretary-General Kofi Annan told delegates: "Technology has given birth to the information age. Now it is up to all of us to build an information society. From trade to telemedicine, from education to environmental protection, we have in our hands, on our desktops and in the skies above the ability to improve standards of living for millions upon millions of people."

Targets include bringing all schools, villages, governments and hospitals online, and ensuring that half the world's population is within reach of ICT, by 2015. Issues discussed included Internet governance, the financing of ICT investments in underserved economies, intellectual property rights, universal access policies and content.

Partnership announcements included a US$ 400,000 grant by the US government for ICT development in low-income countries; a memorandum of understanding signed by Cisco and the International Telecommunication Union (ITU) to open 20 Internet training centres in developing countries; an agreement by Hewlett-Packard to provide low-cost products that will help overcome the ICT illiteracy barrier; and a five-year, billion dollar programme by Microsoft and the UN Development Programme (UNDP) to bring ICT skills to underserved communities.

One initiative announced at the summit was a project in which the government of India will provide "e-post" services to Bhutan via a US$ 400,000 satellite network and solar power system in order to improve communications with that country's more remote mountainous areas. Partners include the ITU, Bhutan Telecom and Post, Worldspace and Encore India.

The cities of Geneva and Lyon and the government of Senegal announced contributions totalling about EURO 1 million as the first three payments into a proposed Digital Solidarity Fund, the establishment of which is to be considered further in Tunis.

For more information, see: www.itu.int/wsis. ◆

Sustainability in master's degree programmes

Cornell University in Ithaca, New York, has received a US$ 5 million gift for the purpose of increasing the study of global environmental and sustainability issues in its Master of Business Administration programme. And a Swedish university has announced a new master's degree programme on sustainability inspired by The Natural Step, an organization that began in Sweden and has since spread to several countries.

The Cornell gift is the latest in a series of donations from Samuel C. Johnson, chairman emeritus of S.C. Johnson and Son Inc. (better known as Johnson Wax), a Cornell graduate and founding member of the World Business Council for Sustainable Development. An earlier gift established a professorship in sustainable global enterprise to improve students' understanding of sustainability and prepare them to lead enterprises that are ethical, equitable, and economically and environmentally sustainable.

"Strategic Leadership Toward Sustainability," the one-year international master's programme at the Blekinge Institute of Technology in Karlskrona (on Sweden's south coast), is based on The Natural Step Framework devised by Karl-Henrik Robert, who is in charge of course development. The first class of 50-60 students will enter the programme in the autumn of 2004.

For more information, contact: Linda Myers, Cornell University, Tel: +1 607 255 9735, E-mail: llm3@cornell.edu; Blekinge Institute of Technology, 371 79 Karlskrona, Sweden, E-mail: sustainabilitymasters@bth.se, or Jill Rosenblum, The Natural Step, 116 New Montgomery Street #800, San Fran-

cisco, CA 94105, USA. E-mail: jrosenblum@naturalstep.org, Internet: www.naturalstep.org. ◆

EU agreements on packaging and technology

The European Parliament and Council have agreed to increase minimum recycling targets for packaging waste from 25% to 55% by 2008. The agreement, reached in conciliation committee, ends a long debate on revision of the 1994 Packaging and Packaging Waste Directive. The final two issues were whether incineration should count as "recovery" and the deadline for Greece, Ireland, Portugal, and the new accession countries to meet the targets.

The European Court of Justice had ruled that incineration of municipal waste is to be considered disposal, not recovery, if its main purpose is to dispose of the waste – regardless of whether energy is recovered as heat or electricity in the process. EU countries that have used incineration as part of their strategy to meet the targets fall short of their goals under this ruling. However, the new agreement allows these countries to continue counting incineration in the short term while stating that the issue will be reviewed in the EU Thematic Strategy on Waste Prevention and Recycling, now in preparation.

The deadline for Greece, Ireland and Portugal to achieve the [illegible] was set as 2011. The deadline for access[illegible]es will be set under a proposal to be issued by the European Commission allowing the new countries to participate fully in decision making on their transition periods. Following confirmation by the Council and Parliament, the new directive is likely to enter into force early in the spring of 2004. It will need to be transposed into national legislation by the autumn of 2005.

In other EU action, the Commission has adopted an action plan to improve the development of environmental technologies and widen their use. This plan aims to overcome barriers to development and deployment through a concerted effort to help maximize the potential of environmental technologies.

The plan contains 11 priority actions for the Commission, national and regional governments, industry and other stakeholders, including:

- the launch of three "technology platforms," bringing together researchers, industry, financial institutions, decision makers and other stakeholders to build a long-term vision on research needs and market developments. Platforms on hydrogen and fuel cells and on photovoltaics start in early 2004, while that on water supply and sanitation will be launched in early 2005;
- development of ambitious environmental performance targets for key products, processes and services;
- mobilization of financial institutions to share the risks of investing in environmental technologies, with a focus on climate change, energy and small and medium-sized enterprises.

Implementation has already begun. The Commission is to give a progress report in 2006.

As part of the initiative, the Commission is establishing a European Panel on Environmental Technologies which will bring together the various stakeholders involved in the plan to improve exchange of information.

For more information, contact: European Commission, Environment DG, Information Centre, Office: BU-9 01/11, B 1049 Brussels, Belgium. Fax: +32 2 299 61 98, Internet: http://europa.eu.int/comm/environment/index_en.htm. The full list of actions proposed in the new action plan is at http://europa.eu.int/comm/environment/etap. ◆

Court halts Hong Kong land reclamation

Hong Kong's top court ruled in January that a major land reclamation project in Victoria Harbour cannot go ahead. The Court of Final Appeal said the waterway is a natural heritage site that must be preserved: "Reclamation would result in permanent destruction and irreversible loss of what should be protected."

Victoria Harbour, Hong Kong

The Society for Protection of the Harbour Ltd (which has fought the government over harbour reclamation for years) brought the original suit, resulting in a High Court ruling against the government which the Appeals Court confirmed. The group said all such projects should now be halted and reviewed in the light of this ruling.

Victoria Harbour originally covered some 7000 hectares. By 1997, when a Protection of the Harbour Ordinance was enacted, over 3100 hectares had been turned into land. Despite the ordinance, the government had proposed reclaiming a further 636 hectares.

For more information, see: www.friendsoftheharbour.org (click on Press Releases). ◆

GHG emission trading market is flourishing

Trading of greenhouse gas (GHG) emissions more than doubled between 2002 and 2003 (the second year in a row), the World Bank reported in December at the ninth Conference of the Parties to the United Nations Framework Convention on Climate Change. COP9 was held in Milan, Italy.

In its third annual study of the global GHG emission market, the Bank said around 71 million tonnes of emission credits were traded, with (for the first time) governments and multilateral agencies accounting for over half the purchases. The study, prepared for the Bank's Carbon Finance unit, said about half the emission reductions traded in 2003 came from electricity generation projects.

So-called "project based transactions" intended for compliance with the Kyoto Protocol to the UNFCCC accounted for most of the 2003 trading volume. Companies and governments of industrialized countries taking part in these transactions receive emission reduction credits in exchange for investments that reduce GHG emissions in transition economies and developing countries.

See: http://carbonfinance.org and www.natsource.com. ◆

WBCSD adds China to regional network

In January the China Business Council for Sustainable Development officially became the 48th member of the World Business Council for Sustainable Development's regional network. The BCSD is the first organization of its kind in China. It brings together a cross section of national and foreign companies to promote more sustainable practices.

The Council was founded as a joint effort by the WBCSD and the China Enterprise Confederation (CEC). Its board includes WBCSD members Sinopec, Novozymes, BASF, Shell, BP and Lafarge.

For more information, contact: Geneviève Tremblay, WBCSD, Geneva, +41 22 839 31 08, E-mail: tremblay@wbcsd.org, Internet: www.wbcsd.ch. ◆

Other climate change news

The European Union will miss its emission targets under the Kyoto Protocol unless Member States adopt additional measures to reduce GHG emissions, says a report adopted by the European Commission. The decreasing emission trend since 1990 was reversed in 2000 and 2001. In letters to the 15 EU environment ministers, Environment Commissioner Margot Wallström urged countries to identify additional measures and speedily carry out those already adopted.

See: http://europa.eu.int/comm/environment.

❖❖❖

A study published in *Nature* says global warming threatens between 15 and 37% of Earth's species with extinction by 2050. Researchers report that some of the losses are inevitable in view of damage attributable to GHG already in the atmosphere. Chris Thomas, professor of conservation biology at Leeds University (UK), was lead author of the study, which was carried out over two years by 18 researchers for six world regions representing one-fifth of the planet's land area. "We had no idea of whether [global warming] would lead to the extinction of a few species or a really substantial number," Thomas told *The Independent* newspaper (London).

"Our analyses suggest that much more than a million species could be threatened with extinction as a result of climate change."

See: www.nature.com (issue of 8 January 2004).

❖❖❖

Another study published in *Nature* indicates that extreme summers, like that of 2003 in Europe, are likely to become more frequent due to global warming and increased climate variability. Christoph Schar of the Swiss Federal Institute of Technology in Zurich, and scientists at the Swiss meteorological service, carried out the study based on records from the past 150 years. "Our simulations show that, roughly speaking, every second European summer is likely to be as warm, if not warmer, than the summer of 2003," Schar told the news agency Reuters.

See: www.nature.com (issue of 22 January 2004).

❖❖❖

New research from NASA in the United States suggests that emissions of black soot may be responsible for 25% of observed global warming during the past century. In areas with snow and ice soot absorbs more of the sun's energy and warmth than would pristine white ice. If snow and ice covered areas begin to melt, the warming effect increases as the soot becomes more concentrated on the surface, researchers said. This phenomenon may contribute to trends towards early springs in the northern hemisphere, thinning Arctic sea ice, and melting glaciers and permafrost – as well as atmospheric changes.

See: www.nasa.gov.

❖❖❖

The World Economic Forum has established a public Web site on which corporations can record their GHG emissions. The Global Greenhouse Gas Register was launched at the UNFCCC Conference of the Parties in Milan. Data registration began in January 2004. The first emission data are expected to be posted on the site in March of this year.

See: www.ghgr.org.

(For other news on global warming and climate change, also see UNEP Focus and DTIE Highlights.

Industry Updates

French corporate reporting improves

In its latest survey France's Social and Environmental Reporting Research Institute reports marked progress in French companies' 2002 social and environmental reporting, compared with the previous year.

The Institute studied the 2002 annual reports of the 120 largest French groups listed on the Paris Stock Exchange, as well as Electricité de France. It compared their results with the Global Reporting Initiative grid of indicators, which it noted was the most complete benchmark for sustainability reporting and the only one that allows international comparisons. The results showed that 27 reports had distinctly improved between 2001 and 2002. However, the gap between leaders and laggards had increased.

The study showed considerable disparity in reporting among sectors. The leaders tended to be in the following groups: services to public authorities (Suez, Véolia), general retailers (Carrefour), automobile and parts (Renault, PSA), and food producers and processors (Danone).

The Social and Environmental Reporting Research Institute is made up of representatives of French academic, corporate and consulting organizations.

In another French survey, the quarterly Novethic Indicator revealed substantial growth in the French market for socially responsible investment funds in 2003. At the end of the year 108 funds existed, compared with 80 twelve months earlier and around 60 at the end of 2001. Assets under management totalled EURO 4.4 billion, compared with 2.5 billion at the end of 2002.

For more information, contact: Carole Crozat for the study on annual reports, E-mail: carole.crozat@terra-nova.fr (copies of the report, in French, are available); also see www.novethic.fr/novethic/images/upload/Indicateur_Q4_2003.pdf (in French). ◆

Major cell phone hazard study proves inconclusive

The jury is still out on whether cell (mobile) phones are bad for human health, according to one of the most comprehensive surveys yet performed. A study of electromagnetic fields by an independent expert group at Sweden's Radiation Protection Authority reviewed three years of international research on exposure to radio frequency fields used by mobile phones and any links with cancer, the blood-brain barrier and heat shock proteins.

"In none of these areas have there been breakthrough results that have warranted firm conclusions one way or the other," says the study report, released in January. Some consumer groups and scientists claim electromagnetic microwave radiation from cell phones and base stations can cause headaches, nausea and perhaps even brain tumours.

Lars-Erik Holm, Director-General of the Radiation Protection Authority, said after the study was released that the agency is continuing to recommend that people reduce their exposure by using hands-free headphones if they are worried about potential hazards from cell phone use. The Swedish expert group will report on this question annually.

Earlier in January Finland's Radiation and Nuclear Safety Authority published a study of 12 phone models from leading manufacturers including Nokia, Samsung and Motorola. The study reported that radiation levels emitted were well below the agreed maximums for Europe.

For more information, see: www.stl.se/english/english_news.html. ◆

New Canadian tool for sustainability reporting

Four senior Canadian cabinet ministers have sent a letter to companies listed on the Toronto Stock Exchange encouraging them to demonstrate corporate leadership by using a new government-developed tool, the Internet-based Corporate Sustainability Reporting Toolkit.

The toolkit Web site contains information and guidance on such key points as what sustainability reporting is, whether to report, and how to do so. Companies are encouraged to tailor the structure and content of their sustainability reports to the nature of their business and the interests of stakeholders.

For more information, see: www.sustainabilityreporting.ca. ◆

Egypt and France join Global Compact

Over 200 leaders representing Egyptian business, government, civil society and academia gathered in Cairo on 9 February to launch the Global Compact in Egypt. It was the first launch of the

Compact in an Arab country.

Abdel Moneim Bekhit, head of the Egyptian Federation of Industries, presented a declaration by Egyptian Global Compact participants pledging continued advocacy and support of the Compact and calling on the Egyptian business community to take part in the initiative. He also announced 35 new Global Compact participants, bringing the total number in Egypt to 52.

In January a similar event took place in Paris, as France formally joined the Compact. Bertrand Collomb, CEO of Lafarge, agreed to serve as Chairman of the French network. More than 140 French companies have joined the Compact.

For more information, see: www.unglobalcompact.org. ◆

US renewable energy sales continue to rise

Certified renewable energy sales in the United States rose significantly in 2002, according to the Center for Resource Solutions in San Francisco. In an annual report tracking renewable energy retail sales, supply and pollution benefits, the Center says the total of over 1.9 million MWh in 2002 was roughly double that in 2001.

2002 sales resulted in the equivalent of more than 1.2 million tonnes of avoided CO_2 emissions. Jan Hamrin, the Centre's Executive Director, explains that the report "confirmed that participating providers exceeded their commitments to customers in total renewable energy product content for the fifth year in a row." ◆

UNEP Focus

UNEP

Compensation for use of biological resources

A study commissioned by UNEP and the World Intellectual Property Organization (WIPO), presented in February 2004 at the Conference of the Parties to the Convention on Biological Diversity in Kuala Lumpur, highlights the complexities of compensating countries, communities and indigenous peoples for knowledge and genetic resources. It also discusses practical issues in regard to ensuring equitable sharing of benefits of access to and use of such resources.

The independent study by Anil K. Gupta, a well-known expert on benefit sharing in relation to genetic resources and traditional knowledge, underlines shortcomings in existing voluntary agreements and suggests how these could be improved to ensure that the custodians of genetic resources and traditional knowledge receive a share of any benefits derived from their commercial use.

The examples cited include a medication derived from an Indian plant with apparent fatigue-relieving properties, and a gene from a wild form of West African rice that is being used in the biotech industry.

New drugs, industrial products and genes for improved crops are continually being sought from plants and animals, particularly in the genetically rich developing world. A key issue at the Kuala Lumpur meeting was the need to develop an international "access and benefit sharing" system to promote breakthroughs from plant and animal sources, while recognizing the rights of those who cultivate and preserve the resources and/or understand their uses.

In Germany annual retail sales of over the counter herbal drugs are estimated at US$ 3.5 billion. An article in the UK's *New Scientist* magazine in January, on a study to be published by WWF, says 4000 to 10,000 plant species may be at risk worldwide because demand for herbal remedies threatens natural habitats and wild medicinal plants are being harvested to extinction. Establishing rules by which companies and local communities share in the profits and the non-monetary benefits of harvesting such resources should generate incentives to conserve biodiversity and reduce the threat of overexploitation.

Intellectual property has been a controversial but important tool in establishing benefit-sharing regimes. Use of traditional knowledge to guide research and develop new products has led to campaigns for traditional knowledge to be protected through intellectual property measures that respect the collective interests and cultural values of traditional communities.

The recently adopted Bonn Guidelines on access and benefit sharing outline roles and responsibilities both for those doing "bioprospecting" and for those with the knowledge and genetic resources. A key issue at Kuala Lumpur was whether such voluntary guidelines are adequate.

For more information, contact: Nick Nuttall, UNEP Head of Media. Tel: +254 20 623084, Mobile: +254 733 632755, E-mail: nick.nuttall@unep.org, or WIPO Media Relations and Public Affairs Section. Tel: +41 22 338 8161/338 95 47. ◆

Also in Kuala Lumpur, UNEP's World Conservation Monitoring Centre released the first comprehensive survey of the Earth's cloud forests, which provide habitats for thousands of rare and endangered species as well as water supplies for farms, rural communities and many rapidly growing cities. Cloud forests are under increasing threat from agriculture, road building, climate change and other factors, the study pointed out.

Cloud Forest Agenda reports that this rare, fragile forest type covers just under 400,000 square kilometres, or less than 2.5% of the globe's tropical rain forests. Surprisingly, the study found that the majority of these forests are in Asia rather than Latin America, contrary to previous estimates; 60% are located in Asia, 25% in Latin America and 15% in Africa.

For more information, contact: Will Rogowski, UNEP-WCMC. Tel: +44 1223 277314, E-mail: will.rogowski@unep-wcmc.org. ◆

African meeting addresses water issues

The Pan African Implementation and Partnership Conference, which took place on 8-12 December 2003 in Addis Ababa, brought together around 1000 delegates and 45 water and environment ministers from African countries, along with representatives of intergovernmental organizations, NGOs and other key stakeholders. The meeting was held to address the implications of the World Summit on Sustainable Development (WSSD) for regional water initiatives and the continent's role in putting the WSSD Plan of Implementation into effect.

African countries, the international community and UN agencies reaffirmed their commitment to resolving Africa's water crisis and pledged to carry out the African Water Vision and the Water Agenda of the New Partnership for Africa's Development (NEPAD), as well as to meet the WSSD targets and Millennium Development Goals on water and sanitation. The outcomes of the conference will aid in preparations for the next meeting of the Commission on Sustainable Development in April.

The principal outcomes included endorsement of water initiatives submitted by each of the five subregions and the launching of the following initiatives: the African-EU Strategic Partnership on Water Affairs and Sanitation; the African Water Facility; the Rural Water Supply and Sanitation Initiative supported by the African Development

Bank: Water and Sanitation for African Cities (Phase II); the G8 Action Plan on Water for Africa; and the African Water Journal.

For background on some of these initiatives, see the article about meeting the MDG targets for water supply and sanitation in Africa on page 22 of this issue. For detailed information on the Addis Ababa conference, see: www.uneca.org/panafcon and www.iisd.ca/vol05/enb05200e.html. ◆

Global warming puts ski resorts in peril

Many low-altitude ski resorts face economic hardship (perhaps even ruin) as a result of global warming, according to a University of Zurich study launched by UNEP at the World Conference on Sport and the Environment in Turin, Italy, on 2-3 December 2003. The report says levels of snow falling in lower-lying mountain areas will become increasingly unpredictable and unreliable in coming decades.

Some 15% of Swiss ski resorts already have unreliable levels of snowfall. Eventually, 37% to 56% of resorts could have such low levels of snow that many will face acute difficulties in attracting visitors. The impact "may be even more severe in countries such as Germany or Austria due to the lower altitudes of their ski resorts," the report by Rolf Burki and colleagues says. North American and Australian resorts will not be spared. In the worst case scenario none of Australia's ski resorts will be economically viable by 2070.

"As ski resorts in lower altitudes face bankruptcy, so the pressure in highly environmentally sensitive upper-altitude areas rises," the researchers pointed out. They also suggested that warmer temperatures would make artificial snow increasingly inefficient and expensive, if not impossible, to produce.

UNEP Executive Director Klaus Toepfer, while stressing that "the poorest of the poor" in developing countries will be the hardest hit by climate change, said: "Winter sports and tourism are big business in many of the world's mountain areas. They offer important sources of revenue and employment for sometimes remote communities. The study shows that it is not just the developing world that will suffer."

For more information, contact: Nick Nuttall (see above). ◆

UNEP Division of Technology, Industry and Economics (DTIE) HIGHLIGHTS

New Director for DTIE

Monique Barbut, officer in charge UNEP's Division of Technology, Industry and Economics (DTIE) since September 2003, has been appointed director of the division, succeeding Jacqueline Aloisi de Larderel, who retired the previous April.

Mrs. Barbut, who is French, was formerly with France's principal aid agency, the Agence Française du Développement, in charge of operations with French overseas departments and territories and Executive Director for Caribbean, Pacific and Indian Ocean activities. Before that she held a variety of posts with France's economic development bank, the Caisse centrale de cooperation economique, first on the Indian Ocean island of Réunion and later as head of project financing in French overseas territories and on activities related to evaluation.

Monique Barbut

During the 1990s her work was increasingly involved with the issue of financing sustainable development. She was a member of the French government delegation to the 1992 Earth Summit in Rio, where she was involved in negotiations on finance. She went on to play an active role in the founding of the Global Environment Facility and was the first head of the GEF's French arm.

UNEP Executive Director Klaus Toepfer, in announcing the appointment, noted that DTIE had important roles in two key projects resulting from the 2002 World Summit on Sustainable Development: developing a global framework for sustainable consumption and production patterns, and promoting effective public-private partnerships.

For more information, contact: Robert Bisset, UNEP Spokesperson for Europe, Tel: +33 1 44 37 76 13, Mobile: +33 6 22 72 58 42, E-mail: robert.bisset@unep.fr. ◆

Key FI partner's new environmental policy

Citigroup, the largest US financial institution and a member of the UNEP DTIE Finance Initiative, announced in January that, under a new corporate policy, it would scrutinize requests for project financing that could adversely affect the environment, ban funding for illegal logging and invest in sustainable forestry and renewable energy.

The move followed two years of demonstrations by the Rainforest Action Network, which praised Citigroup as the first US bank to adopt such a comprehensive policy. The group's new guidelines are stricter than the Equator Principles drawn up by the World Bank's International Finance Corporation, which Citigroup and several other US and European banks have endorsed.

Citigroup Chief Executive Charles Prince said the bank could "make a difference by holding ourselves accountable for our own impact on the environment" and by "engaging in the public domain on these issues."

For more information, see: www.citigroup.com/citigroup/environment/initiatives.htm. ◆

Rotterdam Convention enters into force

With Armenia becoming the 50th country to ratify the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the treaty takes effect in late February.

"We now have an effective system in place for avoiding many of the deadly mistakes made in past decades when people were less aware of the dangers of toxic chemicals," said Klaus Toepfer, UNEP's Executive Director. "The convention, whose early entry into force was urged by the World Summit on Sustainable Development in Johannesburg last year, will contribute to the WSSD's aim of ensuring that, by 2020, chemicals are used and produced in ways that minimize significant adverse effects on human health and the environment."

Jointly supported by UNEP and the United Nations Food and Agriculture Organization, the convention helps importing countries decide which potentially hazardous chemicals they can or cannot manage safely, and it requires labelling and information on potential health and environmental effects. Most of the signatories of the Rotterdam Convention so far have been developing countries.

The treaty initially covered 27 substances, but five additional pesticides have been flagged for inclusion and many more substances are likely to be added. The first conference of the parties to the convention will take place in Geneva in late 2004.

For more information, contact: Michael Williams, UNEP Information Officer in Geneva, Tel: +41 22 917 8242/8196/8244, Mobile: +41 79 409 1528, E-mail: michael.williams@unep.ch, Internet: www.pic.int. ◆

Costly disasters and a call for emission trading

Natural disasters, largely weather related and probably linked with climate change, cost the world over US$ 60 billion in 2003, compared with around US$ 55 billion the year before, experts from the Finance Initiative report. UNEP Executive Director Klaus Toepfer urged government and business to back trading systems for greenhouse gas emissions as one response to the trend.

Munich Re, one of the world's biggest re-insurance companies, and other members of the Finance Initiative's Climate Change Working Group, reported that the heat wave in many parts of Europe, which resulted in some 20,000 deaths and major crop and livestock damage, was probably the most costly single event, with agricultural losses alone estimated at over US$ 10 billion.

Flooding on China's Huai and Yangtze rivers, which damaged some 650,000 apartments, was likely the second most costly event, estimated at nearly US$ 8 billion.

The largest insured losses were from tornadoes in the US Midwest, which are calculated to have

cost insurers more than US$ 3 billion.

In conjunction with the report, the Climate Change Working Group launched a briefing document, aimed at the Chief Executive Officers of large corporations, highlighting the opportunities and challenges of emission trading (see Books & Reports, below).

Munich Re's full findings on the economic and insured costs of weather related natural catastrophes in 2003 were expected to be published at the end of the year.

For more information, see: www.munichre.com (click on "Press\Media"). ◆

A gift of power for rural India

BP Solar USA, one of the world's leading solar power companies, is donating over US$ 1 million worth of solar modules to the Basel Agency for Sustainable Energy (BASE), a UNEP Collaborating Centre, for use in areas of India where over 60% of the population is without electricity. The systems, totalling 635 kilowatts, will power water pumps, lights and telecommunication services such as cybercafes.

Virginia Sonntag-O'Brien, BASE Managing Director, said: "Lack of access to reliable and affordable energy is one of the main obstacles to economic development in developing countries. These solar photovoltaic modules ... will not only help overcome this hurdle, but will do so in a clean and non-polluting way."

Some of the panels will be sold by Syndicate Bank of India, which has programmes promoting solar-powered pumping and lighting in rural areas. The resulting revenue will help fund installation of the remaining panels in areas where customers will pay an affordable fee for the service.

Other partners in the initiative include DHL, Danzas Air and Ocean, Swiss Re, Good Energies Inc., Dasag Energy Engineering and Netpro Renewable Energy India.

For more information, contact: Virginia Sonntag-O'Brien, Tel: +41 61 274 0480, E-mail: virginia.sonntagob@energy-base.org. ◆

Global partnership award is launched

A women's network in India is collaborating with British engineers and a French water company to improve water delivery to impoverished urban areas. In Ecuador, a consortium of European companies is working with the government and coffee farmers to ensure that pesticides don't contaminate water supplies. In South Africa, a small-business owner is working with women's cooperatives and the government to test-market solar technology in rural areas.

Such innovative partnerships are the focus of a global award programme launched by UNEP and other groups in January at the World Social Forum in Mumbai, India, and the World Economic Forum in Davos, Switzerland. The SEED Awards (for "Supporting Entrepreneurs in Environment and Development") will reward people and organizations that work in partnership to devise innovative strategies for the sustainable use of natural resources.

The awards will be given for partnership proposals that show great promise and could serve as models. The partners – community groups, businesses, worker organizations, local authorities and the like – will receive support in developing business plans, seeking funding and setting up partnerships.

"Partnerships between NGOs, governments, and companies are generating new ideas on how to balance economic, social and environmental needs in a sustainable way," says Miguel Araujo of IUCN – the World Conservation Union, another of the sponsoring organizations. "However, not many people know about their success, why they are important, or how partnerships may be useful in their own communities."

The SEED Awards will be presented every two years. Other groups involved in the initiative are the Stakeholder Forum for Our Common Future, the United Nations Development Programme, Partnerships Central, the Global Public Policy Institute, the German government and the United Nations Global Compact Office.

For more information, contact: Robert Bisset (see above) or see www.seedawards.org. ◆

Books & Reports

General

Your Guide to the UN Global Compact: A Resource Package

The United Nations Global Compact Office and the five UN "core agencies" (including UNEP) in the Global Compact programme have put together this introduction and awareness-raising tool to make the programme and the principles it outlines better known. The package is in CD-ROM form, compatible with PC and Mac, and regular updates will be available. The aim is to help companies and other organizations integrate the Global Compact's principles into their daily operations. The package covers the three main areas of the compact – human rights, labour and the environment – in separate presentations, including case studies. The material was developed by the International Labour Organization and UNEP DTIE, with input and assistance from the three other "core agencies": the Office of the High Commissioner for Human Rights, the United Nations Industrial Development Organization, and the United Nations Development Programme.

(2003). Global Compact Office, 1 United Nations Plaza, New York, NY 10017, USA, Tel: +1 212 963 4861, Fax: +1 212 963 1207, E-mail: globalcompact@un.org, Internet: www.unglobalcompact.org. CD-ROM.

Mapping the Journey: Case Studies in Strategy and Action toward Sustainable Development

In a collection of 11 in-depth case studies and three short "vignettes" from around the world, *Mapping the Journey* documents the progress of several organizations – and one country, the Netherlands – that have committed themselves to moving towards sustainable operations. The case studies, based in part on many personal interviews, focus on the management processes used to promote sustainability at Volvo, Patagonia, Henkel, SC Johnson and other organizations. The intent is to provide clear examples that other organizations can follow. An introduction describes the concepts involved and outlines a "model for a sustainable future economy."

L. Rowledge et al. (2003). Greenleaf Publishing Ltd., Aizlewood Business Centre, Aizlewood's Mill, Nursery Street, Sheffield S3 8GG, UK, Tel: +44 114 282 4375, Fax: +44 114 282 3476, E-mail: info@greenleaf-publishing.com, Internet: www.greenleaf-publishing.com. Pbk., 288p. ISBN 1-874719-26-8.

Environmental Citizenship: An Introductory Guidebook on Building Partnerships between Citizens and Local Governments for Environmental Sustainability

UNEP's International Environmental Technology Centre describes this guidebook as having been inspired by citizen groups in Shiga Prefecture, Japan, where the Osaka-based IETC has an office. Shiga is the site of Lake Biwa, Japan's largest lake and the source of water for some 14 million people. When organic pollution led to a disastrous "red tide" in the lake in 1977, a group of housewives began working for the elimination of phosphate detergents, which were largely responsible for the pollution. The women organized seminars, formed a partnership with the local government and by 1980 had succeeded in having the detergents banned locally (a nationwide ban followed a few years later). Drawing upon this case, as well as case studies from California and Africa, the guidebook outlines the principles and building blocks of environmental citizenship and describes seven key steps in partnership building. This publication is part of the IETC's Integrative Management Series.

(2003). UNEP/DTIE/IETC. Available from EarthPrint Ltd., PO Box 119, Stevenage, SG14TP, UK. Tel+44 1438 748 111, Fax: +44 1438 748 844, E-mail: orders@earthprint.com, Internet: www.earthprint.com. Pbk., 15p. ISBN 92-807-2304-9.

Perspectives on Industrial Ecology

The field of industrial ecology, only a decade or so old, is based on the concept of industrial systems and their societal interactions forming an integral part of the biosphere. This volume is composed in part of contributions from speakers at a conference on industrial ecology organized by the editors in Troyes, France, in 1999. The first part introduces the concepts of industrial ecology and industrial metabolism, tools such as material flow analysis and life cycle assessment, and the role of technology. Parts 2 and 3 focus on current activities in the field and future challenges. The chapters are interspersed with short commentaries and case studies.

D. Bourg and S. Erkman, eds. (2003). Greenleaf Publishing Ltd. (see above). Hbk., 384p. ISBN 1-874719-46-2.

Applied Industrial Ecology: A New Platform for Planning Sustainable Societies

Aimed primarily at policy makers and planners, this book focuses on applications of industrial ecology and material flow analysis in developing countries, using case studies from India. It is less academic and more practical in its approach than the volume reviewed above, as the aim is to show that the concept can provide solutions in the real world. The book gives an introduction to industrial ecology and examples from several types of industry, including textiles and foundries. With a foreword by Fritz Balkau, head of DTIE's Production and Consumption Branch.

S. Erkman and R. Ramaswamy (2003). Aicra Publishers, 808, "B" Wing, Mittal Tower, M.G. Road, Bangalore, India 560 001, Internet: www.aicra.com/industrial-ecology.html. Pbk., 159p. ISBN 81-88848-01-8.

Energy

Energy Subsidies: Lessons Learned in Assessing Their Impact and Designing Policy Reforms

This report follows a series of regional workshops on energy subsidy reform organized by UNEP DTIE's Economics and Trade Branch and the International Energy Agency in 2000-01, and many of the chapters build on presentations and discussions from the workshops. It presents the case for reducing, removing or restructuring subsidies that lead to environmental harm and have high financial and economic costs. The report looks at the OECD countries as a bloc, along with selected countries of central Europe, Asia, Africa and South America, evaluating the environmental and social effects either of subsidies in general or of support aimed at specific energy forms such as coal and electricity. An appendix describes various methodologies for analysis of the economic, environmental and social effects of energy subsidy reform. The report was funded by the United Nations Foundation.

(2003). UNEP/DTIE/ETB. Available from EarthPrint Ltd. (see above). Pbk., 173p. ISBN 92-807-2277-8.

Climate change/ air pollution

Clean Development Mechanism: Introduction to the CDM

(2003). UNEP. Pbk., 32p. ISBN 87-550-386-6. Also available in French (see below) and Spanish (*Mecanismo de Desarrollo Limpio/ Introducción al MDL*).

CDM Information and Guidebook

(2003). UNEP. Pbk., 100p. ISBN 87-550-3279-6.

These companion volumes on one of the key provisions of the Kyoto Protocol form part of UNEP's "CD4 CDM" project ("Capacity Development for the Clean Development Mechanism"), which is being carried out by the UNEP Risø Centre on Energy, Climate and Sustainable Development (formerly the UNEP Collaborating Centre on Energy and Environment) at Risø National Laboratory in Roskilde, Denmark. The CDM was conceived as a way to promote foreign investment in greenhouse gas emission reduction in developing countries. The four-year, Dutch-funded UNEP project aims to help developing countries participate fully in this mechanism. *Clean Development Mechanism* provides a brief introduction to the CDM and describes pilot GHG reduction projects. Much of this booklet is incorporated in the second chapter of *CDM Information and Guidebook*, which also covers such issues as sustainable development indicators and the CDM project cycle.

Available from UNEP Risø Centre on Energy, Climate and Sustainable Development, Risø National Laboratory, Bldg. 142, Frederiksborgvej 399, PO Box 49, DK 4000 Roskilde, Denmark, Tel: +45 46 32 22 88, Fax: +45 46 32 19 99, Internet: http://cd4cdm.org.

Emissions Trading: Climate Change Working Group Statement

The latest "CEO briefing" from the UNEP Finance Initiative unit of the Economics and Trade Branch looks at the issue of greenhouse gas emission trading from a financial sector perspective. Introduced in December at the ninth Conference of the Parties to the UN Framework Convention on Climate Change, this eight-page briefing paper covers the political and market framework for emission trading under the UNFCCC and Kyoto Protocol, risk management tools from the banking and insurance perspectives, and going beyond compliance with international agreements by offering "GHG-neutral" products and services.

(2003). UNEP/DTIE/ETB. Available for download in PDF format at http://unepfi.net.

National/regional

OECD Environmental Performance Reviews: Austria, Mexico, Netherlands, Poland

The latest country studies in the OECD's second series of Environmental Performance Reviews (EPRs) include an assessment of countries' responses to the recommendations made by the OECD in the first series. Like the earlier EPRs, the new series presents information on each country's management of environmental media, waste and biodiversity. Each title also covers environmental-economic and environmental-social integration and policy implementation. The Environmental Performance Reviews are published in English and French.

Austria (2003). Pbk., 2XXp. ISBN 92-64-10XXX-X.

Mexico (2003). Pbk., 244p. ISBN 92-64-10501-8.

Web Site Highlights

Help with tech transfer
www.estis.net

UNEP DTIE's International Environmental Technology Centre has launched a Web-based tool to help transfer environmentally sound technologies (ESTs). Called the EST Information System, or ESTIS, it comprises three integrated components that make up a decentralized network for improving access to (and local control of) EST-related information. The three components allow users to build their own Web sites, share EST resources, and search for EST information.

Consumption/production database
www.p2win.org/NASCA

The North America Sustainable Consumption Alliance (NASCA) has launched a Web database of initiatives and activities on sustainable consumption and production in Mexico, the United States and Canada. It contains over 200 entries on issues such as advertising and marketing, children and youth, cleaner production, consumer products, lifestyle choices, organic products, poverty, procurement, tourism, trade, transport and waste. Aimed chiefly at supporting cooperation among organizations in the three NAFTA countries, the database is also intended as a resource for citizens who want to know more about projects or initiatives they can support, join or emulate in their own communities. Anyone can propose entries on the Web site. UNEP DTIE is a partner in the database, along with the North American Commission for Environmental Cooperation, the Canadian Centre for Pollution Prevention, Environment Canada, the Lowell Center for Sustainable Production, the Integrative Strategies Forum and the University of Sonora.

Eating sustainable seafood
www.montereybayaquarium.org

The Monterey Bay Aquarium in California has published a guide to sustainable seafood eating, available on line as part of the aquarium's Seafood Watch programme (on the home page click "Seafood Watch"). With West Coast regional and national information sheets for the United States, the program categorizes fish, shellfish and other marine products into "best choice," "caution" and "avoid" lists. Categories are based on human health concerns as well as environmental ones. Pocket guides can be printed out from the Web site.

French resource on companies, funds
www.novethic.fr

Novethic, a resource centre affiliated with the Caisse des dépôts et consignations, the French government's investment bank, provides information on corporate social and environmental responsibility and socially responsible investment funds on its Web site. In the two and a half years since it went on line, the site has archived more than 1500 articles, teaching guides, databases and other resources compiled by journalists and experts as well as Novethic staff members. Many resources, such as the Novethic newsletter, are free. Others are available by subscription or for one-off fees. In French.

Environmental law in French
www.environ-line.com

The French trade publisher Editions Lamy, which specializes in legal and technological publications, has launched this French language subscription site to provide up-to-date information on French and European environmental legislation, especially that affecting industry. The resources include a news service and access to official texts such as the Code de l'environnement and the *Journal officiel*.

IEA solar power information
www.iea-pvps.org

The International Energy Agency's Photovoltaic Power Systems Programme not only describes this IEA research and development agreement but is also a good all-round source for information about solar PV power. The site includes links for the PV Power newsletter, case studies, national and international statistics and quick links on topics such as aid agencies, costs and prices, builders and developers, and financing.

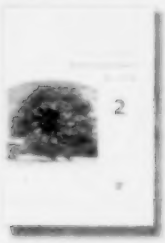
Netherlands (2003). Pbk., 248p. ISBN 92-64-10100-4.

Poland (2003). Pbk., 216p. ISBN 92-64-10096-2.

Available from OECD Publications, 2 rue André Pascal, 75775 Paris Cedex 16, France. Tel.+33 1 45 24 81 67. Fax: +33 1 45 24 19 50. E-mail: sales@oecd.org. Internet: www.oecd.org/bookshop.

Editions françaises

Entreprises et développement durable



Ce deuxième tome « Entreprises et développement durable » fait le point sur la mise en œuvre des stratégies de développement durable à travers les témoignages d'une centaine d'entreprises adhérentes du Comité 21, Comité français pour l'environnement et le développement durable. Portraits, Innovations et Expertises constituent les trois principaux chapitres de l'ouvrage. Les portraits, 22 au total, s'appuient sur des analyses de rapports de développement durable et des entretiens avec des entreprises qui ont mis en place des stratégies de développement durable et disposent du recul nécessaire pour identifier les avancées et les freins. Suivent neuf retours d'expériences qui ont été sélectionnés pour leur efficacité d'un point de vue environnemental, économique et sociétal et pour leur caractère précurseur. Dans le dernier chapitre, la parole est donnée à 15 experts qui interviennent auprès d'entreprises pour la mise en œuvre de stratégies ou de pratiques.

(2003). Comité 21, 132 rue de Rivoli, 75001 Paris, France. Tel. : +33 1 55 34 75 21, Fax : +33 1 55 34 75 20. 138p. ISBN 2-911520-07-6/9782911520075.

Mécanisme pour le développement propre – Introduction au MDP

Cette brochure propose une introduction synthétique du mécanisme établi dans le cadre du Protocole de Kyoto. D'une durée de quatre ans et financé par le ministère néerlandais des Affaires étrangères, le MDP a pour objectif général de développer les capacités institutionnelles et humaines que nécessite sa mise en œuvre dans les pays en développement. La brochure synthétise les apports et les bénéfices nationaux découlant de la participation au MDP. Elle comporte également une description du processus, de la conception et la formulation du projet jusqu'à la vérification et à la certification de la réduction des émissions de gaz à effet de serre. Ce projet d'envergure du Programme des Nations Unies pour l'environnement (PNUE) est mis en œuvre par le Centre Risø du PNUE sur l'énergie, le climat et le développement durable (anciennement Centre de collaboration du PNUE sur l'énergie et l'environnement du laboratoire national danois Risø).

(2003). UNEP Risø Centre on Energy, Climate and Sustainable Development, Risø National Laboratory, Bldg. 142, Frederiksborgvej 399, PO Box 49, DK 4000 Roskilde, Danemark, Tel : +45 46 32 22 88, Fax : +45 46 32 19 99, Internet : http://cd4cdm.org. 34p. ISBN 87-550-386-6. Publié également en anglais (voir plus haut) et en espagnol (Mecanismo de Desarrollo Limpio).

THE UNEP DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS

Current uses and development of natural resources, technologies and production processes, as well as urbanization patterns, have negative effects on human health and the environment. This is illustrated by unsustainable use of water, land and energy, air and water pollution, persistent and toxic bio-accumulative chemicals in the food chain, and other industry-related problems.

To have a healthy environment, we need to change how we produce and consume goods and services. This change involves revising and developing economic policies and trade practices, so as to integrate environmental issues in the planning and assessment processes.

UNEP's Division of Technology, Industry and Economics (UNEP DTIE) was created in 1998 to help decision-makers in governments, local authorities and industry develop and adopt policies and practices that:

- are cleaner and safer;
- use natural resources efficiently;
- ensure adequate management of chemicals;
- incorporate environmental costs;
- reduce pollution and risks for humans and the environment.

UNEP DTIE, whose main office is in Paris, is composed of:

◆ **The International Environmental Technology Centre (Osaka)**, which promotes the adoption and use of environmentally sound technologies, with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.

◆ **The Production and Consumption Unit (Paris)**, which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.

◆ **The Chemicals Unit (Geneva)**, which promotes sustainable development by catalyzing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety world-wide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).

◆ **The Energy and OzonAction Unit (Paris)**, which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of this Unit.

◆ **The Economics and Trade Unit (Geneva)**, which promotes the use and application of assessment and incentive tools for environmental policy, and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.

UNEP
UNITED NATIONS ENVIRONMENT PROGRAMME
DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS
39-43, QUAI ANDRE-CITROËN
75739 PARIS CEDEX 15, FRANCE
TEL: (33) 1 44 37 14 50
FAX: (33) 1 44 37 14 74
E-MAIL: unep.tie@unep.fr
http://www.uneptie.org

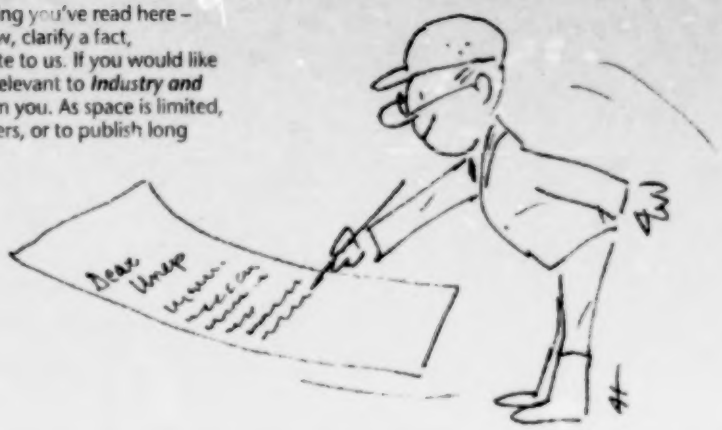
FEEDBACK

If you would like to respond to something you've read here – to agree or disagree with a point of view, clarify a fact, or provide additional information – write to us. If you would like to air your views on any other subject relevant to ***Industry and Environment***, we also hope to hear from you. As space is limited, we cannot guarantee to publish all letters, or to publish long ones in full.

Send your Feedback letters to:

Feedback
Industry and Environment review
UNEP DTIE
Tour Mirabeau
39-43, quai André-Citroën
75739 Paris Cedex 15, France

Fax: +33 1 44 37 14 74
E-mail: unep.tie@unep.fr



Industry and Environment

a publication of the United Nations Environment Programme
Division of Technology, Industry and Economics

For over 20 years, the quarterly *Industry and Environment* has provided a forum for exchanging information and experience. Articles are contributed by industry managers, government officials, researchers and others active in the field of sustainable industrial development. Besides reporting on developments of broad international interest, each issue focuses on a particular theme. The themes of recent issues have included the agri-food industry, consumption patterns, urban environmental management, sustainable energy, and mining and sustainable development. Recent issues and archives are available on-line at www.uneptie.org/media/review/ie_home.htm.

The next issue of *Industry and Environment* will focus on chemicals management.

Industry and Environment is an English language publication, but it often includes articles in French and Spanish. All contributed articles are accompanied by summaries in English, French and Spanish.

The review is also published in Chinese.
For further details, please contact:
Professor Liu Xiaogwang
Research Center for Eco-Environmental Sciences
Chinese Academy of Sciences, P.O. Box 2871, Beijing 100085, China

Industry and Environment
SUBSCRIPTION ORDER FORM
Subscription per volume: US$ 60.00

Name: _____
Organization: _____
Address: _____
_____
Country: _____
(Delete as applicable)
E-mail/Tel./Fax Number: _____

❒ I enclose a cheque for $_____ €_____
(Made payable to EarthPrint Limited in US dollars or Euro equivalent)

❒ Please debit my credit/debit card as follows:
Card name (Amex/Visa/Mastercard): _____
Number: _____ Expiry date: _____

To order online, visit **http://www.earthprint.com**

Note: Institutions and public libraries may request billing.
Companies and individuals, please send payment along with this order form.
Back issues may also be ordered from EarthPrint

Please send your order with payment to:
EarthPrint Limited
P.O. Box 119, Stevenage, Hertfordshire SG1 4TP, United Kingdom
Fax: +44 1438 748 844, E-mail: subscriptions@earthprint.com

With copy to: UNEP DTIE, 39-43, quai André-Citroën
75739 Paris Cedex 15, France
Fax: +33 1 44 37 14 74, E-mail: unep.tie@unep.fr